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CHAPEL HILL, N. C., U. S. A.

The Elisha Mitchell Scientific Society

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JOURNAL

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Volume XL December, 1924 Nos. 3 & 4

PROCEEDINGS OF THE TWENTY-THIRD ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE

HELD AT TRINITY COLLEGE, DURHAM, N. C.,
MAY 2 AND 3, 1924

The Executive Committee of the North Carolina Academy of Science met at the Faculty Club of Trinity College, Thursday night, May 1, with all members present, with Prof. Lasley acting for Prof. Henderson.

The following recommendations were adopted:

1. That we invite Mr. W. E. Wickenden to address the Academy for thirty minutes on Saturday morning.

2. That we extend the time for W. W. Wood to thirty minutes and for F. P. Venable to twenty minutes.

3. That all bills as presented by the Treasurer be paid.

The following recommendations were adopted to be presented to the Academy:

1. That Prof. G. M. Robison of the Mathematics Department of Trinity College and Dr. Otto Stuhlman, Jr., of the Physics Department of the University, be requested to represent the Academy at the International Mathematical Conference and the British Association meetings to be held in Toronto during the summer.

2. That a legislative committee be created to look after the interests of science during the next session of the legislature in North Carolina.

3. That titles not submitted to the Secretary before the program goes to press may not be called for until the entire printed program, including second papers, has been called for. It is understood that papers called for and not presented will pass to the foot, that is below the titles not appearing on the program.

The Executive Committee elected the following to membership:

Boomhour, J. G., Meredith College, Raleigh, N. C.
Burroughs, R. E., State College, Raleigh, N. C.
Campbell, Roy J., Salem College, Winston-Salem, N. C.
Canaday, E. F., Dept. Math., Meredith College
Cooper, S. A., Durham High School, Durham, N. C.
Crawford, J. C., Dept. Agriculture, Raleigh
Curran, H. M., Dept. Agriculture, Raleigh
Douglas, J. M., Davidson College, Davidson, N. C.
Ellison, W. A., Graduate Student, Trinity College, Durham, N. C.
Harrelson, Miss P. V., Dept. Psychology, Davenport College, Lenoir, N. C.
Harris, J. A., Dept. Agriculture, Raleigh, N. C.
Harvey, J. V., Fellow in Botany, University of North Carolina, Chapel Hill, N. C.
Hall, Earl H., N. C. C. W., Greensboro, N. C.
Hood, Frazer, Dept. Psychology, Davidson College
Horne, Hugh J., Chemist, Spindale, N. C.
Howell, E. V., Dean Pharmacy School, University of North Carolina
Jackson, D. C., Jr., Dept. Engr'g, Trinity College
Kilpatrick, Martin, Jr., Dept. Chemistry, Trinity College
King, Miss Rena, Cary High School, Cary, N. C.
Marion, S. J., Lenoir College, Hickory, N. C.
Markham, E. C., Trinity College
Meacham, F. B., Dept. Zoology, State College
Meares, J. S., State College
Robison, G. M., Dept. Math., Trinity College
Rodgers, S. E., Jr., State College
Shamburger, Miss Anne, Peace Institute, Raleigh, N. C.
Slay, R. J., Chemistry Dept., Greenville, N. C.
Smithey, S. B., University of North Carolina
Snyder, L. H., Dept. Zoology, State College
Summerell, Miss Frances, Winston-Salem High School
Taylor, H. M., Dept. Chem., University of North Carolina
Willis, L. G., Soil Chemist, State College
Williams, A. S., Chemist, State College

Removed from Academy Roll

By death: M. E. Sherwin.
By removal from state: G. W. Vaughn, H. N. Gould.
By withdrawal: Mary Robinson.
By non-payment of dues: G. H. Satterfield, Mary Seymour, Blanche Shaffer, H. G. Smith, S. C. Smith, W. F. Taylor, H. M. Vann, Ruth Walker, J. H. Williams, D. B. Wilson, R. S. Pritchard, E. C. Linderman, B. Mabee, J. E. Ivey, N. B. Foster, Wayne Burch, W. J. Andrews, S. C. Clapp, J. S. Babb, L. Baker, N. M. Paul, F. A. Grant, R. B. Wilson, R. W. Sullivan.

The Committee heard the report of the Treasurer, and transmits it to the Academy for auditing and publication.

The Academy was called to order by President Heck promptly at 10:30 Friday morning. There was an unusually good attendance for the first paper, which was called for after a few introductory remarks. Papers were presented in order until 12:55, when the President appointed the following committees:

Nominating—C. S. Brimley, W. A. Withers, W. C. Coker.

Auditing—J. W. Nowell, A. W. Hobbs, E. E. Randolph.

Resolutions—B. W. Wells, Collier Cobb, Lula G. Winston.

The Academy adjourned to meet at 2:30, at which time the reading of papers was resumed and was continued until 4:30, when the Academy went into a business session.

As there were no corrections to the minutes, which were approved, committee reports were called for.

The Executive Committee presented a report of its meeting and presented its recommendations, all of which were adopted. It also presented the names of applicants elected to membership during the year.

The Auditing Committee reported that the books of the Treasurer had been examined and found to be correct. They recommended the publication of the summarized report. The report of the Committee was adopted, and the summarized statement appears below.

Income		Expenditures	
Balance last Audit	156.00	Postage	23.25
Dues 1922–3 collected	44.00	Secretary Expense Greensboro meet	12.07
Chemists	5.00	Multigraphing, etc	17.00
Dues 1923–4	263.00	Secretary Comm	30.00
	468.00	Elisha Mitchell J	175.00
To balance		Stenographic aid	41.00
		Dues refund B. Cunningham	2.00
		Refund I. H. Manning	1.00
		Programs	20.00
		Amer. Assoc. Dues B. W. Kilgore	4.00
			325.32
		To balance	142.68
			468.00

	1924	1923
Balance on checking account	142.68	156.00
Balance saving account	326.55	314.91
	469.23	470.91
Checks on hand	10.00	

Compiled May 1, 1924.
BERT CUNNINGHAM, *Treasurer.*

Audited May 2, 1924.
(Signed) J. W. NOWELL,
E. E. RANDOLPH,
A. W. HOBBS.

The High School Committee submitted the following report which was considered section by section. This report was adopted except section 7, which was rejected when it was found that this would duplicate to a considerable degree, the work of the State Department of Education.

Your Committee reports that:

(1) A section of Science has been organized in the Teachers Assembly, and that this section met at the time of the general assembly in Raleigh and produced a program. About 20 to 25 teachers attended these meetings.

(2) That the visitation of high schools by members of the Academy under the directions of the State Department has been continued. It is expected that the results of such visitations will be presented to this body by J. Henry Highsmith who is sponsoring the movement. More details concerning the movement will be given by B. W. Wells of the publicity committee.

(3) That in the absence of one of our members, Prof. R. N. Wilson, who sponsored the idea of an "Information Bureau" for the employers of high school teachers, no move has been made to the present along this line.

Your Committee recommends that the Academy go on record (1) as approving the policy of the State Department requiring science in the approved high schools, and its minimum apparatus requirement; (2) as recommending that the State Department of Education now consider the advisability of requiring a minimum of training for science teachers in the subjects which they expect to teach; (3) as

recommending that the State Department of Education consider the advisability of a "differential salary" for the present, of thoroughly equipped science teachers; (4) as recommending that the policy of school visitation be continued, if desired by the Department of Education; (5) as recommending that the State Department consider the advisability of allowing two advanced courses in science to be substituted for one of the courses required in education; (6) as recommending that the Information Bureau be worked out during the ensuing year, the necessary funds to be appropriated by the Executive Committee; (7) that the Secretary of the Academy be requested to call the attention of educational institutions to the need of better preparation of science teachers, and (8) that we advise the appointment of a full time, thoroughly equipped science supervisor for high schools.

BERT CUNNINGHAM,
A. F. ROLLER,
R. N. WILSON,
J. N. COUCH.

The Publicity Committee report was called for. B. W. Wells reported for the lectureship unit. His report follows.

The Academy members have during the past year been able to make some definite and significant contributions to High School science progress.

1. The following members have under the auspices of the State Dept. of Education, made addresses to students, teachers and the public in the interest of High School science: Bert Cunningham, C. M. Heck, B. W. Wells.

2. Certain members of the Academy have acted in an advisory capacity in relation to the organization of high school science equipment, materials and furniture. The plans of the physics, chemistry and biology which are to be put into the new vocational high schools will be worked out under the direction of members of the Academy.

3. A number of Academy members attended the last meeting of the High School Science Teachers' Association where they were able to demonstrate a sympathetic and helpful attitude to that Association.

Especially prominent in the work of elevating science to its proper place in our high schools is Professor C. M. Heck. Professor Heck has made some intensive studies of the secondary school science situation both outside of and within the state and is vigorously pushing a

number of policies which when they mature will mean much for science progress in North Carolina.

Bert Cunningham reported verbally for the loan unit that some progress had been made for the preparation and distribution by loan of certain sets of lantern slides. In the absence of R. W. Leiby, he made a statement concerning the newspaper publicity. These reports were adopted. It was moved and seconded that all newspaper publicity should be placed in the hands of the Secretary.

The Natural Resource Committee made a verbal report concerning the preparation of a description of the ecological areas of North Carolina for the Naturalists Guide Book of the Americas, which is being published by the Ecological Society of America.

The Constitution Committee reported that the constitution was ready for publication, but that the publication of it had been delayed, awaiting the report of the Reorganization Committee.

The Nominating Committee reported as follows:

President—H. B. Arbuckle, Davidson College.

Vice Pres.—Lula G. Winston, Meredith.

Sec.-Tres.—Bert Cunningham, Trinity.

Executive Committee—C. M. Heck (3 yr.), State College; J. P. Givler (1 yr. replace H. B. Arbuckle), N.C.C.W.; A. Henderson (2 yr.) University.

The Secretary was instructed to cast the ballot for the above officers and this was done.

Owing to the considerable discussion concerning the high school report, the reports of the Reorganization Committee and the Resolutions Committee were postponed until the Saturday morning session.

The Academy adjourned at 6:15 to become the guests of Trinity College for supper at Southgate Hall. It was reassembled at 8:15 for the presidential address. Vice-President Givler presided, and in a few words introduced President W. P. Few of Trinity College, who extended a cordial welcome to the Academy. President Heck was then introduced. His address on "Science of the Future and for the Future," published in full in this number, was one of the most thought-provoking addresses the Academy has heard.

Following this address, the Faculty Club of Trinity College was host to an informal reception at the Club house. The Academy convened at 9:00 Saturday to hear an address by Mr. W. E. Wickenden, Investigator for the Society for Promotion of Engineering Education.

Following this, the report of the Reorganization Committee was called for. The following report was submitted and adopted.

The Reorganization Committee recommends that (1) the policy of sections be approved, (2) that there be as few sections as convenient, (3) that there be at present no separate biological section, (4) that a committee be appointed to work out details of sectional organization, to be applied next year, and that plans for future procedure be presented at the next meeting.

The report of the Resolutions Committee was then called for. The report was submitted in three sections. The first two of the following were adopted by a rising vote.

1. It is with profound sorrow and regret that the Academy takes cognizance at this time of the death during the past year of Prof. M. E. Sherwin.

In the death of Professor Sherwin, the Academy has suffered the loss of a capable scientist, one who was not only interested in all the activities of the Academy, but one who had a wide vision of the significance of science in all human groups.

The North Carolina Academy of Science desires to express and put on record its deep regret that Professor Sherwin's span of years has been terminated so prematurely. The Academy desires the Secretary to forward the above statement to Mrs. M. E. Sherwin and to express to her the sympathy of every member of the organization.

2. In addition to the expressions of the individual members the North Carolina Academy of Science as an organization, desires to present through its Resolution Committee a statement of appreciation of the cordial reception and unexcelled hospitality which it has enjoyed at the present meeting. To the Faculty of Trinity College and especially to all those in immediate charge of arrangements, the Academy expresses its sincere thanks for such generous and royal treatment.

3. Whereas, among the many attacks that have recently been made on evolution, there frequently appears the statement that "evolution is a discarded and discredited theory" and whereas this statement is totally incorrect, therefore,

The North Carolina Academy of Science hereby declares that to the best of its information and belief, practically all biologists look upon evolution not as a theory, but as an established fact.

It furthermore declares that the statements that evolution has been abandoned arise from the fact that there exists several schools of inter-

preters of evolution (one of which schools is known as the Darwinian school), and the disputes among these schools have given rise to the idea that "Darwinism" and therefore evolution have been abandoned by scientists, whereas the controversies between these schools have no more discredited the main facts of evolution than the differences between the Christian sects have discredited the main facts of Christianity.

We furthermore declare that we believe evolution to be merely the regular and ordinary method by which God works in the natural world.

B. W. WELLS,
COLLIER COBB,
LULA G. WINSTON,
Committee.

The third section of the Resolutions called forth debate which proceeded for a short time, when a motion to adjourn was made and seconded. A motion to adjourn to reconvene in two minutes was given precedence over the motion to adjourn, by the chair. This motion was carried.

Upon reconvening, it was moved and seconded that a committee, with Mr. Brimley as chairman, be appointed to reword the section, with instructions to report next year. This motion did not carry.

It was moved and seconded to accept the first paragraph, including the preamble. It was moved to amend by changing the word "biologists" to "scientists," and by changing an "established fact" to an "established law of nature." Thus amended, this paragraph was passed. On motion, the following paragraphs were lost.

The Academy then convened as sections and continued the reading of papers.

The following papers were read. (Those marked with an * appear in full in this JOURNAL, those with an x are abstracted in this number. No abstracts have been received for those unmarked.)

x*The Ecological Position of the Eastern Pine Communities.* B. W. WELLS.

**A Non-mathematical Interpretation of the Theory of Relativily.* W. W. WOOD.

**Amoeboid Behavior of the Lymph Cells in Sea Urchins.* H. V. WILSON.

x*The Bromination of 2-Amino-p-Cymene and the Preparation of Derivative Azo Dyes.* A. S. WHEELER AND H. M. TAYLOR.

x*Studies in Ascidian Blood.* W. C. GEORGE.

Extra Area of Hard Surface Due to Widening Roads Around Sharp Curves. T. F. HICKERSON.

x*Identification Trials.* C. S. BRIMLEY.

x*Experiments on Mental Set.* J. F. DASHIELL.

Evolution of the Nesting Habits of Birds. (By title). Z. P. METCALF.

Present Day Problems in Engineering Education. W. E. WICKENDEN.

x*Rainfall Characteristics of North Carolina.* T. SAVILLE AND J. H. WULBERN.

**Opportunities for Chemical Industries in North Carolina.* E. E. RANDOLPH.

Local Engineering Problems in Forestry. (Read by B. W. Wells.) W. W. ASHE.

Brownian Movements. (By title.) F. P. VENABLE.

**Improvements in the High School Science Situation.* J. H. HIGHSMITH.

**Variations in the Proteins of Corn.* H. B. ARBUCKLE AND O. J. THIES.

Soybean Diseases. F. A. WOLF.

**New Megachilid Bees.* T. B. MITCHELL.

x*Soft Pork and its Causes.* J. O. HALVERSON AND EARL HOSTETLER.

x*Methods for Class Demonstration of Hydrogen Sulfide Formation by Bacteria.* I. V. SKUNK.

The Hydrogen Ion Concentration of the Intestines in Relation to the Intestinal Protozoan Parasites. (By title.) M. J. HOGUE.

x*A Botanical Collecting Trip up Grandfather's Mountain.* (Read by H. L. Blomquist.) P. O. SCHALLERT.

The Biological Determinant vs. the Environmental Determinant. (By title.) C. C. TAYLOR.

x*The Morphology of Certain Phylloxera Galls on the Hickory.* A. C. MARTIN.

An American vs. a Tubercle Bacillus. (By title.) CHARLES PHILLIPS.

Recent Experiments on Wintering Honeybees. J. C. ECKERT.

The Effect of Dry Heat on Certain Enzymes of the Cotton Seed. S. G. LEHMAN.

Vitality of Albino Rats for Experimental Purposes. (By title.) F. W. SHERWOOD.

**Injection of the Blood Vessels of Young Chick Embryos.* W. R. EARLE. Pres. by H. V. WILSON.

**Water Dogs (Necturus) of North Carolina.* (By title.) C. S. BRIMLEY.

x*A Neglected Factor in Maze Learning.* J. F. DASHIELL.

Some Results of Soft Pork Investigation II. (By title.) J. O. HALVERSON AND EARL HOSTETLER.

x*Structure of the Heart Muscle of Ascidia.* W. C. GEORGE.
Homopterous Head. (By title.) Z. P. METCALF.
Some Notes on Gossypol. F. W. SHERWOOD.
Gossypol in Relation to Nutrition. W. A. WITHERS.
A Microscopic Study of Dune Sands and Loess from China. COLLIER COBB.
**The Loess Deposits of China.* COLLIER COBB.
x*Summability of Infinite Series and Products.* G. M. ROBINSON.
A New, Semi-parasitic Species of Aphanomyces. W. C. COKER AND J. N. COUCH.
Notes on Pythium dictiosporum Raciborski, with a Description of a New Species of Achlyogeton Parasitic on it. J. N. COUCH.

The following papers were read before the North Carolina section of the American Chemical Society meeting in affiliation with the North Carolina Academy of Science.

Latent Heats of Fusion of Some Nitrotoluenes as Calculated from Melting Point Depressions. J. M. BELL.
x*The Action of Phenylsemicarbazide on Acetyl Acetone.* A. S. WHEELER AND F. P. BROOKS.
Devitrification of Quartz Ware. F. C. VILBRANDT.
x*The Occurrence of Borneol in Spruce Turpentine.* A. S. WHEELER AND C. R. HARRIS.
The Chemical Analysis of Okra Seed (Hibiscus esculentus). B. NAIMAN AND L. M. NIXON.
x*The Chlorination of 2-Amino-p-Xylene and Certain New Azo Dyes.* A. S. WHEELER AND MILDRED MORSE.
A Connection Tube for Gas Burners. F. C. VILBRANDT.
x*The Action of Amines on Dichloro- and Trichloroacetic Acids.* A. S. WHEELER AND E. D. JENNINGS.

The following papers were read before the North Carolina Physics Teachers Association meeting in affiliation with the North Carolina Academy of Science:

Formation of Molecules. W. E. SPEAS.
Scientific Research in North Carolina. C. W. EDWARDS.
Physics Laboratory Manuals. W. T. WRIGHT.
Secondary Electrons Produced by Electronic Bombardment of Metals. D. A. WELLS AND O. STUHLMAN.
Liquefaction of Gases. J. B. DERIEUX.
A Compact Form of the McLeod Gauge. A. A. DIXON.

The following papers were read before the Society for the Promotion of Engineering meeting in affiliation with the North Carolina Academy of Science:

Symposium on the Work of the Investigating Committee, Society for Promotion of Engineering Education. Led by W. E. WICKENDEN.

Reports of the Local Committee on Investigation, and Discussion of its Work by Members of the Committee consisting of G. M. BRAUNE, Chairman, A. C. HOWELL, Secretary, C. W. EDWARDS, D. C. JACKSON, JR., H. B. SHAW, L. L. VAUGHN.

The Teaching of English for Engineers. T. P. HARRISON.

The list of membership has become so long that it seems inadvisable to publish it each year. However, the Secretary has on his permanent record a complete list of those attending each meeting, the number this year amounting to 115.

BERT CUNNINGHAM,
Secretary.

The following abstracts have been received:

The Ecological Position of the Eastern North Carolina Pine Communities. B. W. WELLS.

Pinus taeda forms two types of communities with regard to succession (1) edaphic climax communities on sterile soils and (2) developmental communities on fertile soils. The former occur chiefly in the upland areas of the Coastal Plain; the latter, on the valley slopes of the Piedmont and upper Coastal Plain.

The fundamental conditions back of the appearance of the climax community are superior tolerance of sterility which frees the shade intolerant pine from competing with the broad-leaved trees. The fundamental conditions back of the developmental community are the disturbance of the original deciduous forest plus superior tolerance of shade on the part of the broad-leaved elements.

The usual treatment of these communities places them in different formations: the eastern broad-leaved mesophytic forest is set apart from the coastal pine community. This is believed to be illogical and undesirable since the pine is practically as mesophytic as most of the oaks, and since the same species occurs as a dominant in the successional pine associations of the "deciduous mesophytic forest." Viewed from the habitat standpoint the factor differences accounting for the isolation of the climax pine communities are believed not to be

of sufficient magnitude to warrant the erection of a major ecological group—and habitat incidentally must be considered or the observations are not ecological ones.

The above considerations are based on the definition of formation as a community characterized by major distinctive physiognomy associated with a major distinctive habitat and the definition of association as a community within the preceding, characterized by minor distinctive physiognomy associated with minor distinctive habitat.

On such a truly ecological basis the developmental and climax communities become developmental and climax associations under the single great mesophytic forest formation of the upland areas. Such a treatment avoids the unfortunate attempt to force the same species to function as a dominant in associations belonging to different formations.

All that has been stated in regard to *Pinus taeda* is in great part applicable to *Pinus palustris*.

The Bromination of 2-Amino-p-Cymene and the Preparation of Derivative Azo Dyes. ALVIN S. WHEELER and HAYWOOD M. TAYLOR.

When 2-amino-p-cymene is brominated in the cold, analysis shows that the product contains one bromine atom. This involves a question of orientation. It is definitely settled that in the nitration of p-cymene the nitro group enters position two. When this compound is reduced 2-amino-p-cymene is obtained. It is possible for the bromine atom to enter either the side chain or the ring. Entrance into the side chain is immediately eliminated since the compound obtained has none of the characterstics of the aliphatic halogen compounds and since the bromination was carried out in the cold. Of the positions in the ring which the bromine atom may enter there are three, namely positions, 3, 5, or 6. There are two lines of attack open for the determination of which position it occupies.

First: the brominated amine was diazotized and the amino group replaced by a bromine atom by means of Sandmeyers reaction, forming a dibromocymene. This compound was then oxidized and a compound, identical with the 2, 5-dibromo terephthalic acid, was obtained. This compound was further identified by preparing the diethyl ester which is identical with the diethyl ester of 2, 5-dibromo terephthalic acid.

Secondly: the brominated amine was acetylated to protect the amino group and then oxidized with neutral potassium permanganate. Analysis for bromine and titration with alkali indicate this compound

to be a monobasic acid and furthermore, a cuminic acid. Upon hydrolysis with sodium hydroxide a compound, identical with the 2-amino-5-bromo-cuminic acid, is obtained.

Since the amino group occupies position 2 in the para-cymene molecule the bromine atom must enter position 5 and the bromination of 2-amino-p-cymene in the cold is thus shown to give 2-amino-5-bromo-p-cymene.

The following new dyes have been prepared:

2, 4 (5-bromo-carvacryl disazo)-phenol.
4 (5-bromo-carvacrylazo)-resorcinol.
2, 6 (5-bromo-carvacryl disazo)-thymol.
2, 4 (5-bromo-carvacryl disazo)-1-naphthol.
1 (5-bromo-carvacrylazo)-2-naphthol.
2 (5-bromo-carvacrylazo)-1-naphthol-4-sulfonic acid.
4 (5-bromo-carvacrylazo)-1-naphthol-2-sulfonic acid.
1 (5-bromo-carvacrylazo)-2-naphthol-7-sulfonic acid.
1 (5-bromo-carvacrylazo)-2-naphthol-6-sulfonic acid.
1 (5-bromo-carvacrylazo)-2-naphthol-3, 6-disulfonic acid.
2 (5-bromo-carvacrylazo)-1, 8-dihydroxy naphthalene-3, 6-disulfonic acid.

The above dyes were made by coupling the diazotized 2-amino-5-bromo-p-cymene hydrochloride with molecular equivalents of phenols or naphthol sulfonic acids. Investigation of the physical and chemical characteristics and dyeing properties of the above is now being carried out.

Studies in Ascidian Blood. W. C. GEORGE.

There is considerable variation in the blood of different genera of ascidians. The blood of *Perophora viridis* contains at least five distinct types of cells with variations of these. These types are: (1) Green cells of a berry-like appearance consisting of a considerable number of green fatty globules imbedded in a scant amount of cytoplasm. The nuclear region can be identified in the living cells as a clear area of cytoplasm in which there are no green bodies. (2) Colorless morula cells consisting of several opaque bodies imbedded in clear cytoplasm. These bodies are strongly eosinophilic – in this respect contrasting with the other types of cells. The nucleus may be found lying in cytoplasm compressed between adjacent bodies. (3) Coarsely granular amoeboid cells, the granules of which appear to be of a fatty nature. (4) Vacuolated amoeboid cells, clear, hyaline in appearance when alive and unstained. Methylene Blue and other

similar vital stains show the presence of numerous fine dancing granules in these vacuoles. These cells may show many vacuoles or they may be a signet ring type of cell with only a single compartment. (5) Orange cells. These cells are similar in structure to the green cells except that the bodies imbedded in the cytoplasm are of an orange color.

Identification Trials. C. S. BRIMLEY.

Gives instances of the difficulties met with in identifying natural history specimens.

Some Experiments in Mental Set. J. F. DASHIELL.

Individuals differ from each other in the quickness with which they get into the mental set for a piece of work. They differ also in their ability *in* the work. Do these two lines of difference parallel each other: is he who most quickly gets *into* a task likely to be the fastest *in* that task? The question was approached with the use of printed arithmetical examples and group intelligence tests, each arranged in two forms, the continuous and the mixed. Definite negative correlations were found between ability in a task and quickness in shifting from one task to another. More elaborate studies of the problem are in progress with apparatus setting distinct kinds of task for right hand, left hand, and feet.

Rainfall Characteristics of North Carolina. THORNDIKE SAVILLE and J. H. WULBERN, JR.

This paper is a continuation of the studies reported upon last year before the Academy in a paper by Thorndike Saville and Roy J. Morton. The present paper explains the presence of a ridge of high rainfall extending from Washington to New Bern as due to the effect of land friction on storm clouds passing inward whereby the lower layers are retarded by friction on the land surface and the upper layers pass on, causing a maximum thickness of water bearing clouds over the area of high rainfall. After this point the cloud layer may increase in thickness, but due to a loss of precipitation in greater ratio than the increase in thickness, the rainfall on the land surface decreases from this point, inward to the bottom of the Blue Ridge, where it begins to increase again. Diagrams are presented showing the relation of precipitation to altitude in passing across two parallels of latitude in the state. Various studies have been made to indicate change of

climate now going on. There seems clear indication that the rainfall at coastal stations from Norfolk to Wilmington has on the whole been declining to a very appreciable extent from 1860 to 1922. There is some indication that the curve of rainfall is now about to swing upward again. At no other points was there any indication of climatic change, although well defined periods of a few years each of high and low rainfall are indicated at all stations. Probability studies have been made to indicate the frequency with which annual rainfalls of given amounts may be expected at various stations in the state. The studies on rainfall and evaporation are being continued.

Soft Pork and its Causes. J. O. HALVERSON and EARL HOSTETLER.

The method of procedure and rations used were shown. The influence of softening feeds and the factors involved are pointed out. This was also shown for hardening feeds. The softening feeds of the South are the peanut and soy beans. The peanut is the chief softening feed. It consists of both high oil and high protein, while in the North the chief feeds are the cereal grains, all high in starch content. Protein is relatively low and this has to be supplied.

The feeds fed were so balanced in the ration that in a single series of experiments one or two factors only could be varied.

Methods for Class Demonstration of Hydrogen Sulfide Formation by Bacteria. I. V. SHUNK.

The following media is suggested for use in class demonstration of hydrogen sulfide formation:

Distilled water	1000.00 cc.
Meat extract	3.0 gms.
Difco peptone	10.0 gms.
Sodium thiosulfate	2.5 gms.
Ferrous sulfate	0.4–1 gm.
Agar-agar	15.0 gms.

The reaction is adjusted to pH 7.0–7.4, and the media sterilized in the autoclave. Inoculations are made by stabbing with the straight wire. Those organisms as *Eberthella typhi, Salmonella paratyphi B.*, etc., which produce hydrogen sulfide rather rapidly, give a very dense blue-black streak along the line of inoculation in 18–36 hours.

This method was compared with the usual lead acetate method.

A Botanical Collecting Trip up Grandfather Mountain, June 16, 1923. P. O. SCHALLERT.

The first stop at Blowing Rock with a beautiful panoramic view of the surrounding mountains with Grandfather Mountain in the background.

Reporting the following interesting plants from over 1000 collected: 65 lichens; 13 mosses; 19 hepatics; 3 shrubs; 9 evergreens; 2 lichens reported for the first time from America; 1 moss new to science described by Prof. J. M. Holzinger; 2 hepatics new to science described by Prof. A. W. Evans; 1 hepatic reported for the first time from America.

The impression made by the sight of Grandfather Mountain.

An Ontogenetic Study of the Gall, Phylloxera Caryaeseptem, Shimer. A. C. MARTIN.

This paper gives a morphological treatment of the developmental features of the *Phylloxera Caryaesetem* Shimer gall and considers particularly the morphogenesis of the septum which is found in young galls of this species. A summary of the paper follows:

1. Two conical "up-walled" chambers, produced by the same aphid develop concurrently on opposite sides of the leaflet and a partition consisting of modified leaf tissue is left as a septum between the compartments.

2. Within the septum the tissues approximate homogeneity and remain as relatively inactive meristem in which some hypertrophy is manifest but in which very little hyperplasia occurs.

3. The septum is an evanescent structure and in its deterioration the mesophyll cells attenuate horizontally and disappear, bringing the two epidermal layers into a temporary union. Eventually the epidermal layers break and the two gall cavities become one.

4. Growth tension appears to be the main factor in transforming the septum.

5. In the region bordering on the septum the meristem (represented by all five of the original leaf layers) expresses itself in prolific activity; dedifferentiation is rapid and is accompanied by extensive hyperplasia. Very pronounced hypertrophy ensues in most of the cells.

6. In point of diversity this gall displays very limited tissue differentiation. A nutritive zone, an extensive parenchymatous region containing vascular tissue and an epidermal layer covering certain parts of the gall's surface, are the chief tissues.

7. Setal punctures are numerous within one gall. Sheaths are often associated with the punctures.

8. Puncture channels were found frequently in tissues of active proliferation as well as in regions of retarded growth.

9. Greatly enlarged starch grains develop in some cells of the parenchyma.

A Neglected Factor in Maze Learning. J. F. DASHIELL.

The maze is a much-used form of experiment in learning, but is not completely adequate for bringing out details of the learning process because results on individual subjects are found to be very irregular and not readily comparable. This is attributed to the fact that the maze does not present the possible errors in a serial or one-way pattern—as is true of all other learning experiments— but makes the subject more liable to re-commit old errors after committing a new one. To check this insight a white rat maze was used equipped with sliding doors that were closed behind the animal as it progressed. Comparison of results with those on the old type of maze showed that the use of doors both reduced the time taken for learning and reduced the irregularity in the learning process.

The Structure of the Heart Muscle of Ascidia. W. C. GEORGE.

The heart of *Ascidia* is a tubular structure consisting of a muscular membrane a single cell thick. The cells of this membrane are elongated cells lying parallel to one another and extending spirally around the tube. On the side of the cells next the lumen of the heart are located transversely striped coarse fibrils imbedded in the cytoplasm. The side of the cells away from the lumen contains the nuclei and many vacuoles.

Summability of Infinite Series and Products. G. M. ROBISON.

The question of assigning a value to a divergent series has been studied considerably during the last forty years. Among the definitions giving a value to a divergent series are those which are expressed by means of linear transformations. Let $S_1, S_2, S_3, \ldots S_n, \ldots$ be the sequence corresponding to the infinite series $\sum_{n=1}^{\infty} u_n$, i.e. $S_n = \sum_{p=1}^{n} u_p$. Form a new sequence t_n, where $t_n = \sum_{p=1}^{n} a_{n,p} S_p$, i.e. t_n is expressed linearly in terms of the first n terms of the original sequence. If $\lim_{n \to \infty}$

t_n exists, we say that this limit is the generalized value of the series by the transformation $A:(a_{n,p})$, $p \leq n$. For such a definition to be useful it must include convergence, that is, if we apply it to a convergent series, the value assigned to the series must be the same as the convergent value. If a transformation A satisfies these conditions, we say that it is regular. The conditions which the terms $(a_{n,p})$ of a transformation must satisfy in order that it be regular are stated in the Silvermann-Toeplitz Theorem.

The theory of infinite product furnishes us an analogous problem. From the given infinite product $\prod_{n=1}^{\infty} (1 + u_n)$ form a new sequence P_n' as follows $P_n' = \prod_{p=1}^{n} (1 + a_{n,p}\, u_p)$. If $\lim_{n \to \infty} \Pi_n'$ exists, we define this limit to be the value assigned to the given infinite product by the transformation $A\ (a_{n,p})$, $p \leq n$. With regard to the regularity of such a transformation, the writer has proved the following:

Theorem. If $\prod_{n=1}^{\infty} (1 \pm u_n)$ converges where $u_n > 0$ to the value P, then a necessary and sufficient condition that $\lim_{n \to \infty} P_n' = P$ where

$$P_n' = \prod_{p=1}^{n} (1 \pm a_{np}\, u_p),\ a_n,$$

being real is that

1) $\lim_{n \to \infty} a_{np} = 1$, for each p

2) $| a_{n,p} | < M$, where M is some fixed constant.

This theorem is not so general as the corresponding Silvermann-Toeplitz therorem in that it only applies to infinite products of real elements.

The Action of Phenylsemicarbazide on Acetyl Acetone. A. S. WHEELER and F. P. BROOKS.

Phenyl semicarbazide and acetyl acetone were allowed to react according to the method of Posner, (Ber. 34. 3980). White needle like crystals formed, melting partly 68–70° and completely at 220°. Two compounds separated by differences of solubility in ethyl alcohol. Low melting body is about 85% of the yield, m.p. 68–70°. Analyzed for 1-phenylcarbamyl-3-5-dimethylpyrazole. Alcoholic solution treated with ammoniacal silver oxide yields white precipitate, of $AgN_2C_5H_7$ showing the loss of the phenylcarbamyl group. $AgN_2C_5H_7$ yields $N_2C_5H_8$ M.P. 105–107° with boiling HCl and subsequent neutralization with

KOH. Identified by picrate described by Rosengarten (Annalen 279 p. 238) M.P. 165° as well as by physical properties of the base as described by Rosengarten. 1-phenylcarbamy-3-5-dimethylpyrazole yields a compound 1-phenyl-carbamyl-3-5-dimethyl pyrazole-bromhydrobromide in gleaming white plates M.P. 260°. Has the bromhydrobromide structure described by Buchner and Fritsch (Annalen 273 p. 263) for bromination product of free pyrazole.

The Occurrence of Borneol in Spruce Turpentine. A. S. WHEELER and C. R. HARRIS.

Cymene residue from spruce turpentine was distilled at 3 m.m. pressure thru a fractionating column. After three distillations the portion coming over between 70–80° (200–210° atmospheric pressure) was cooled to −5° and a white crystalline substance filtered off. On analysis and mol. wt. determination this substance showed the formula $C_{10}H_{18}O$. It was identified as borneol by its m.p. 205°, its phenyl urethane m. 141°, its oxidation to camphor m. 176°, its crystalline form, solubility, optical activity etc. It consisted largely of the levo modification and constituted 1% of the total cymene residue.

The Chlorination of 2-Amino-p-Xylene and Certain New Azo Dyes. A. S. WHEELER and MILDRED MORSE.

2-amino-p-xylene was chlorinated by passing chlorine into a solution of 2-acetamido-p-xylene in glacial acetic acid at 16° until the solution began to turn yellow. The 5-chloro-2-acetamido-p-xylene prepared had a melting point of 176°. Its constitution was proved by the following series of reactions: 5-chloro-2-acetamido-p-xylene→ 5-chloro-2-amino-p-xylene hydrochloride → 5-chloro-2-amino-p-xylene → 2-5-dichloro-p-xylene →2-5-dichloroterephthalic acid. In the chlorination a dichloro compound was also formed. The constitution of this compound has not yet been worked out.

New azo dyes have been prepared by coupling the diazotized 5-chloro-2-amino-p-xylene hydrochloride with various substances containing the OH group. These include compounds with phenol, resorcinol, alpha naphthol, beta naphthol, thymol, Shaffer's salt, Cleve's acid, Chromotropic acid, Neville-Winter's acid, and R acid.

The Action of Amines on Dichloro- and Trichloroacetic Acids. A. S. WHEELER and E. DEW. JENNINGS.

Trichloroacetates and dichloroacetates are formed when amines as benzidine, methyl aniline, p-aminophenol, o-anisidine, 2, 4-dichloroaniline and o-chloroaniline are treated with trichloroacetic acid and dichloroacetic acid.

Some amines as aniline and o-toluidine when treated with dichloroacetic acid are transformed into trichloroacetates as shown by Wheeler and Smith. This very peculiar transformation evidently does not take place when substituted amines are used.

PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY, OCTOBER 9, 1923, TO MAY 13, 1924

266th MEETING—OCTOBER 9, 1923

(40th Anniversary Meeting)

F. P. VENABLE—*Historical Sketch of the Elisha Mitchell Scientific Society.* (Appears in full in Vol. **39:** 117–122. 1924.)

W. C. GEORGE.—*Some Peculiar Amoeboid Cells in Perophora.*

This paper consisted of an account of some observations made during the summer at the Beaufort laboratory of the U. S. Bureau of Fisheries upon the blood of *Perophora*. *Perophora* is a small marine animal belonging to the group of animals known as the Ascidians, degenerate vertebrates that occupy a position in the animal kingdom at the bottom of the vertebrate group. These animals are peculiar in that they have an outer coat composed largely of cellulose, the chief constituent of plant tissues. The mechanics of the circulation is unique in that the animal has a heart that beats alternately first in one direction and then in the opposite. The particular amoeboid blood cells considered in this report constitute a type of cells that, so far as known, have not previously been described or observed. They have several box-like compartments or vacuoles containing rapidly dancing granules that coalesce into larger masses. The function of these cells has not been discovered.

ELECTION OF MEMBERS

The following members of the faculty were elected to active membership in the Society: Mr. F. P. Brooks, Mr. Wilton Cathey, Dr. P. H. Dike, Dr. F. H. Edminster, Mr. P. M. Grey, Dr. D. A. McPherson, Mr. O. E. Martin, Prof. A. Naeter, Mr. W. W. Rogers, Mr. L. M. Sahag, Mr. S. B. Smithey, Mr. I. J. Stephenson, Mr. Frank M. Swartz, Dr. Joel H. Swartz, Mr. R. M. Trimble. The following students were elected to associate membership: From the Department of *Botany*—J. W. Deyton, J. V. Harvey; *Chemistry*—R. W. Bost, A. Boyles, S. H. Gottheimer, C. R. Harris, C. W. Flinton, E. D. Jennings, Miss M. E. Morse, J. H. Mourane, G. M. Murphey, S. E. Murray, W. C. Quimby, S. M. Rollins; *Civil Engineering*—A. S. Chase, J. N. Coffey, J. N.

Gilbert, L. T. Lassiter, Dwight Plyler, F. C. Ray, G. B. Wynne, J. H. Wulbern; *Electrical Engineering*—J. R. Alexander, L. P. Brown, W. H. Butt, E. F. Bowmann, J. F. Chaney, O. L. Giersch, T. B. Jacocks, J. R. Purser, G. F. Seyffert, T. H. Shepherd, F. M. Spaugh, G. S. Stuart, G. A. Thompson, W. Thompson, H. F. Whitaker; *Geology*—C. S. Johnston, T. H. Evans, C. E. Miller; *Mathematics*—C. H. Benson, G. S. Benton, B. B. Dalton, S. F. Jones; *Medicine*—C. H. Ashford, W. R. Berryhill, C. P. Eldridge, W. S. Hester, H. B. Smith; *Pharmacy*—W. R. McDonald, Jr., Paul H. Thompson, H. E. Whitmire; *Physics*—M. L. Braun, V. E. Brown, D. A. Wells, G. F. Wood; *Psychology*—H. W. Martin, W. L. Hinman; *Zoology*—D. C. Corriher, W. R. Earle, E. S. McDaniel, G. T. Penney, Miss Nannie M. Smith, J. D. West.

267TH MEETING—NOVEMBER 13, 1923

PAUL N. DIKE—*Magnetic Surveys by the Carnegie Institution.* (Illustrated.)

A brief historical sketch of the earlier magnetic surveys was followed by a description of the magnetic work undertaken by the Carnegie Institution. Large portions of the earth's surface had never been surveyed, and it was necessary before theories as to the causes of the magnetic field of the earth could be put to the test, to undertake extensive surveys both on land and sea.

The methods of carrying out a land survey were outlined and representative views shown, to give an idea of some of the difficulties encountered by the observers. The work of the Galilee and of the Carnegie, the two magnetic survey yachts that have been used by the Department was described. A chart was shown representing the cruises of the yachts and the land expeditions undertaken, showing the extent of the work done up to the present.

The object and methods of the magnetic observers was discussed, typical records shown, and pictures of some of the observers presented. Some of the associated problems, atmospheric, electricity, earth currents, solar disturbances, etc., were briefly mentioned, and their importance in the formulation of a theory to account for the earth's magnetic field and its fluctuation pointed out.

FRANK C. VILBRANDT—*By-producting North Carolina Coals.*

A review of the history and location of the Deep River Coal Fields of Chatham and Moore counties was given. Production, labor and

transportation difficulties were also discussed. A brief study of the effects of temperature on the coal from the Farmville Mine of the Carolina Coal Company was presented, setting forth the following conclusions from the results obtained:

1. The high volatile coal can be reduced to very high grade metallurgical coke and also coke of any desired volatility for domestic consumption by proper temperature control during by-producting.

2. The temperature of the primary and secondary reactions in the by-producting of this coal are lower than ordinary bituminous coals.

3. The tar distillates and gas evolution tests can be used as criteria in the study of by-producting reactions.

4. That the B. t. U. of the by-product coals at various temperatures does not materially decrease on increased heat treatment.

268TH MEETING—DECEMBER 11, 1923

H. V. WILSON—*Amoeboid Behavior of the Lymph Cells in Sea-Urchins.* (Appears in full in this issue.)

W. DEB. MACNIDER—*The Effect of Changing the Chemical Constitution of the Blood on Kidney Functions and Pathology.* (Illustrated.)

In the animal organism there is constantly being produced as a result of destructive metabolic processes bodies of an acid character. One of the main functions of the kidney is to eliminate such bodies and maintain a normal acid-base balance of the blood and tissue juices. If this balance is not maintained the kidneys as well as other organs are given a blood of such changed chemical constitution that their function becomes impaired as a result of degenerative changes developing in the specialized cells.

This type of kidney injury can be experimentally induced in the dog by injecting intravenously either a N/2 solution of hydrochloric acid or a solution of sodium carbonate equimolecular with a 3% solution of sodium chloride. When the acid-base equilibrium of the blood is so altered either by the introduction of hydrogen or hydroxyl ions as to furnish the kidney an altered physico-chemical environment in terms of its blood supply the renal epithelium becomes edematous and necrotic and renal function is decreased or suppressed.

A committee, consisting of W. C. Coker, R. E. Coker, Otto Stuhlman, Jr. and J. N. Couch was appointed to investigate whether anything is being done by other scientific societies for the aid of German scholars.

269TH MEETING—JANUARY 8, 1924

J. N. COUCH—*A Dioecious Water Mold (Dictyuchus monosporus).*

A somewhat detailed account is given of an investigation in the method of reproduction and variability in the genus *Dictyuchus*. It has been found that the strains of *Dictyuchus* as collected in nature show certain variations which according to the general principles of classification in this group would permit the making of several species, as has already been done.

In strains which were producing sexual fruits the antheridial and oogonial strains have been isolated and grown separately under which conditions they invariably remain sexually sterile, but when the opposite strains are grown together so that their threads intermingle, oogonia and antheridia are formed in the region where the threads are in contact, thus proving the plant to be dioecious or heterothallic.

The opposite strains, with a few exceptions, of the apparently different species may be intercrossed, in which crosses variations occur in the size of the oogonia and eggs and in the character of the antheridia which invalidate any specific distinctions between the species *D. monosporus, D. magnusii, D. carpophorus,* and *D. sterile.*

COLLIER COBB—*Earthquakes, with Special Reference to the Japanese Earthquake of September 1, 1923.* (Illustrated.)

The paper covered briefly investigation of earthquake areas from Guatemala to Alaska and from Aleutian Islands through Japan, made in 1920–21, showing photographs of the faults. In every single line examined, and in all the recent photographs furnished by Japanese friends the fault was a thrust-fault, and these frequently occurred along stream-beds and roadways, where erosion or man's work had produced a slight line-of-weakness.

The committee appointed to investigate whether anything is being done by other scientific societies for the aid of German scholars reported that apparently nothing is being done officially by the other scientific societies. The Committee recommended that the contributions we make for German scientists be made through the American Committee for Relief of German Children. W. C. Coker explained the work of the Food Package Department of this committee and stated that the Committee had offered to deliver to designated individuals, groups or institutions $10.00 food packages. W. C. Coker offered his services in forwarding to the Committee contributions and to do any writing necessary in connection with the work.

270TH MEETING—FEBRUARY 12, 1924

A. W. HOBBS—*The Breaking Strength of Concrete Cylinders as a Function of their Height.*

The practical work of engineering and of all science is very much simplified if the relations which are known to exist between the quantities considered can be expressed in exact mathematical form, that is, as mathematical functions. While the great laws of the universe have been worked out, often from theoretical considerations, and expressed in fairly simple mathematical form, the relations between the quantities that we deal with here on our particular spot of earth do not as a rule lend themselves very well to theory, and the best we can do is to discover a curve, when we know from the data a certain number of its points, a point being represented by a pair of values found by experiment of the two quantities the form of whose relationship we are trying to establish.

In the study of mathematics we learn the equations of a great many curves, so that when we see a curve we have a pretty good idea of the form of its equation. Having drawn the curve of our data we proceed to guess at an equation which will represent it and then see if by changing the coefficients we can make the equation fit the curve. In order to simplify the work we try to find a transformation which will map the given curve into a straight line.

The heights with their corresponding breaking strengths were as follows:

HEIGHT	BREAKING STRENGTH
inches	
3	5766
4	4456
5	3914
6	3618
7	3345
8	3133
9	3140
10	3091
11	3053
12	3109
13	2900

When this data is plotted the curve is of the hyperbolic type. We thus assume its equation to be of the form

$$p = \frac{h}{a + bh}.$$

This equation can be written

$$\frac{a}{h} + b = \frac{1}{p},$$

which is a linear equation in $\frac{1}{h}$ and $\frac{1}{p}$.

These values give approximately a straight line when plotted. The values of a and b are found to be

$$a = -0.000625 \qquad b = 0.000385$$

The function then that states the relationship of breaking strength to the height of the cylinders is

$$p = \frac{10000h}{-6.25 + 3.85h}.$$

J. F. DASHIELL—*Race Differences in Temperament.*

The Downey Individual Will-Temperament Test was applied to the measurement of high school and college students of the negro and white races (about forty individuals in each of the four groups). This test is based upon the handwriting reaction as a convenient motor response involving many of the general factors of voluntary activity such as speed, flexibility, inhibition, coordination, perseverance, etc. In general it was found in this survey that the white group contained a much higher percentage than did the negro groups of individuals of the controlled, deliberate, careful type; a somewhat higher percentage of those of the mobile, rapid-fire type; and a smaller percentage of those of the aggressive type. The last-named fact calls for interpretation probably in terms of compensation by the negro—his submissiveness in general relations with the whites being compensated for by an exaggerated expansiveness when given free opportunity in the test. One qualifying factor of the study not to be neglected is that the negro students tested represented a much higher and narrower selection from their race than did the white students.

271ST MEETING—MARCH 11, 1924

J. M. BELL—*The New Chemical Laboratory.*

H. F. JANDA—*Capillary Moisture in Highway Subgrades.*

At the suggestion of Mr. Charles M. Upham, State Highway Engineer of North Carolina, the School of Engineering undertook a series of

experiments on capillary moisture in highway subgrades. The Highway Commission employed Mr. Roy J. Morton, a graduate student in engineering as a Research Fellow in Civil Engineering and paid for all construction and labour. The School of Engineering supervised and assisted in the design of apparatus.

The first problem was to determine whether or not drain tile would remove capillary moisture. Several soils were tried and the following conclusions reached: (1) That drain tile are of no direct value in removing, or preventing the rise of, purely capillary moisture. (2) That the percentage of capillary moisture is reduced as the elevation of the subgrade above the water table is increased. Therefore, tile drain might reduce the percentage of capillary moisture by lowering the water table. (3) That the percentage of capillary moisture may be reduced by evaporation in connection with horizontal capillary movement, or by a reverse process it might be increased. Therefore, good drainage at the edge of a hard surfaced road will assist in preventing capillary moisture under the pavement itself.

Since drain tile were found not to be effective in removing capillary moisture, a method of preventing the rise of such moisture was next investigated. The object of this series of tests was to establish conclusions as to the value of coarse layers (non-capillary) in preventing capillary action, and so far as possible, determine what non-capillary materials would be the most suitable for this purpose. The following conclusions were reached: (1) That a layer of coarse, non-capillary material is an effective agent in preventing the rise of capillary moisture. (2) That some materials are more effective than others. (3) That sand seems to be the most effective agent in preventing capillary action. This is probably due to the fact that the particles are large enough to prevent capillary action, while the interstices are not sufficiently large to allow fine capillary material to enter and act as a wick to the moisture through the layer.

The Society directed the Recording Secretary to write letters to Hon. Hubert C. Work, Secretary of the Interior, and to Mr. Stephen Mather, Director of the National Park Service, indorsing the movement for establishing a National Park at Glacier Bay, Alaska.

The Society also directed the Recording Secretary to write a letter of congratulation to the Société Linnéenne de Normandie et Société des Antiquaires de Normandie in honor of their Centennial Anniversary which is to be celebrated at Caen (Normandie), France, on May 31 and June 2 and 3.

272ND MEETING—APRIL 12, 1924

STUART J. LLOYD, of the University of Alabama—*Muscle Shoals and Chemistry.*

The key to cheap fixed nitrogen for fertilizer purposes lies in cheap hydrogen. Research work carried on by the Alabama Power Company has resulted in the incidental production of hydrogen (as a by-product) in three cases:

1. *Calcium arsenate,* the only reliable boll weevil remedy has hitherto been produced by the action of nitric acid upon white arsenic, to oxidize it to arsenic acid, and the subsequent precipitation of this arsenic acid with lime. By dissolving white arsenic in caustic soda, and electrolyzing between iron electrodes, the oxidization to sodium arsenate is accomplished, and large quantities of by-product hydrogen are simultaneously produced.

2. *The Estelle process* for electrolytic iron consists in the electrolysis of a *hot, very concentrated,* solution of caustic soda, in which is suspended finely divided iron hydroxide. Here also considerable hydrogen is produced at the cathodes, as in electrolytic zinc production.

3. *Electromagnetic flotation* is a novel method of coal washing, in which a strong magnetic field is used to vary at will the apparent specific gravity of the solution used, which carries a current and produces inevitably a considerable quantity of by-product hydrogen.

273RD MEETING—MAY 13, 1924

A. S. WHEELER—*New Dyes from Spruce Turpentine.* (For abstract of this paper see PROCEEDINGS OF THE N. C. ACADEMY OF SCIENCE, this number, p. 111).

THORNDIKE SAVILLE—*Some Power Investigations on Deep River.* (Illustrated).

A complete power study of Deep River was presented, based on field work comprising a river profile and traverse, cross sections of dam sites, storage studies and estimates of power which may be developed.

The total fall from crest of a proposed 40 foot dam near Jamestown to Moncure is 612 feet in 114 miles. The fall now developed is 302 feet. Of the 310 feet now undeveloped the report indicates how 247 feet may be economically developed, utilizing 90% of the fall of the river.

The stream flow studies indicate very low unit discharge in the fall months. This may be considerably augmented by storage reservoirs. Three such reservoirs with dams 40, 50 and 60 feet high respectively, are recommended. They would serve to increase the low water flow about 300%.

Investigation of silting in existing power ponds indicate that at present more than half the available power is lost through inability to store the night flow. Silt removal methods are considered.

The primary and secondary water power which can be developed at existing and recommended developments is discussed. At present 279 feet fall is developed on Deep and Rocky Rivers with 1147 24-hour primary horsepower and 4597 24-hour secondary horsepower theoretically available. If the rivers are fully developed in accordance with the scheme recommended, 604 feet will be utilized, and there can be produced 8160 24-hour primary and 6774 24-hour secondary horsepower.

By use of mouth-of-mine steam auxiliary station at the Deep River Coal Fields, there may be produced 15,000 continuous 24-hour horsepower or 26,500 10-hour horsepower. The steam plants would have to be used only about one-third of the time.

The results outlined can be obtained economically only by interconnection of all water and steam power plants to form a local super-power system. This system must be operated as a unit. A scheme is indicated whereby the various power interests on the river would combine to form a single organization to effect these ends.

ELECTION OF OFFICERS

The following officers were elected for the year 1924—1925: President—Otto Stuhlman, Jr.; Vice President—H. R. Totten; Permanent Secretary—J. M. Bell; Recording Secretary and Treasurer—Joel H. Swartz; Publications Committee—W. C. Coker, Collier Cobb and J. M. Bell.

THE SCIENCE OF THE FUTURE AND FOR THE FUTURE[1]

By Charles M. Heck

When one attempts to address or represent so large and influential a body of men as compose the North Carolina Academy of Science it well behooves him to meditate on the real purpose for which these men have seen fit to organize themselves and take the time from their work to come together in annual meetings. One might go further and ask what activities of the state are represented by these men and what other activities do the times and conditions naturally place in the hands of this body for direction and inspiration. It is because of these reflections that I venture to depart from the usual custom of the president of this society, and instead of taking the subject of my address from the field of my research, namely sound determinations, consider with you the rather broad but most important question to us all, namely the question of "The Science of the Future and for the Future."

Who is bold enough to turn from the remarkable progress of science in the past and, facing the future, dare foretell her course. Yet science has a future: not only so, but that science of the future may have characteristics very different from those of the past and it may be that we who have chosen science as our means of expression and our life's activity will be vitally affected by such changes. Therefore may not we, who represent science more than any other body of men in the state, do well to inquire as best we may and discover perchance the trend of things enough to be able the better to do our part in guiding those who educate not for today but a generation hence.

An analogy is only an analogy but the one used by Lester Ward to picture the method of science's progress is most apt. Watching the manner of a pool of water in spreading out over level dry ground we note how the action of the water on the periphery shows a peculiar method of expansion. Here a tongue-like process is formed and pushes out much as pseudopods of an amoeba move; there near it another and finally, when the two have grown independently to be larger processes out in the dry ground, a new quick movement is observed and the between ground is covered by a more rapid outpushing of water until

[1] Presidential Address before N. C. Academy of Science, delivered May 2, 1924.

the shore of the pool is again regular. This method of movement would be found all around the circumference of the pool and by these impulsive irregular movements it would grow and move no matter how large the pool itself had become.

Applying the analogy, Ward calls our attention to the striking advance at certain stages in the past of subjects like Physics and Chemistry until there came a time when the more complex between ground was attacked and, with rapid expansion, there developed a new subject we call Physical Chemistry. Thus Bio-chemistry, Astro-physics, Geo-physics and the like have arisen. At any one moment in science history we are attracted by some peculiar development the progress of which for a time exceeds all others. In the end, however, the advance presents an unbroken front and the expanse of the known is ever widened.

If one admits that this analogy illustrates science's method of progressing, certain elements of the future of science as opposed to its past suggest themselves. In the first place, if science attracts attention largely in its growing rather than by what it has already achieved, which so far as the public of the past is concerned is certainly true, with a widening area of knowledge the circumference must grow so large as to make these outbursts of progress in the various fields so frequent and so small relative to the whole that the scientific progress of the future will seldom partake of the spectacular. Then again any expansion of area on all sides makes each element of the momentary outrush so small in comparison with the sum total of the progress already made that the likelihood of a change in the direction of the progress of science as a whole by any new revelation becomes increasingly unlikely.

In short the analogy would cause us to look upon the future progress of science in any one element, much as it was in the past, with genius giving to one subject after another a relatively rapid advance. But in respect to the whole a much slower and more even progress of science will be found. The evolution theory was a relatively larger contribution than anyone should expect to occur again in any like field as it came when the sum of already discovered principles in that field was small.

Also the stability of science is indicated by the analogy. We need only turn to the recent developments in the field of Chemistry to observe this. What seemingly more revolutionary discovery could be made than the recent revelations made with X-Rays as to the nature of the chemical elements and their series relations. One would have

expected a complete upsetting of the foundations of the subject. But was this the case? Was it necessary to rebuild the subject on this new foundation? Not at all; nor is it likely that it will ever be necessary to rebuild our sciences of today.

Men of science need a saner view regarding their own activity. Through all these years they have been laying a foundation sure and deep and discovered truth will stand the acid test of more truth. I believe we will profit in a material way by assuming the stability of present science and desist from expecting the spectacular and upsetting. But the effect on the public in this regard must not be forgotten. Today the press operates with this false expectancy and attempts to satisfy the impatient public by overstatement and misrepresentation of new discoveries. Assurance of stability on the other hand guarantees the lasting worth of scientific research. What more could we ask?

The third suggestion we may get from the analogy of Ward is in regard to the ever increasing periphery of the sum of knowledge. Around the great expanse of known truth we are aware of the greater expanse of unknown. The greater the known the greater the unknown. Who of us but has been impressed with the rapid increase in the volume of the realized unknown. Discover a fact and a dozen questions about it arise to thwart you lest you boast of achievement. If an encyclopedia of today's unsolved questions were compiled it would fill a library. We are justly proud of the acquisition of truth in the present century, but we still find ourselves standing on the shores of an unknown sea looking out on an ever widening expanse of the unknown. Our new knowledge has but enabled us to comprehend better the infinity of that expanse and our powerlessness to comprehend the ultimate. The spherical, perfectly elastic atom of half a century ago suggested a series of problems, whereas the planetary system of electrons that science today recognizes as the atom presents not only a thousand new unknowns but introduces us to new mechanical systems that baffle all known methods of analysis. The same process of unfolding of the simple to find an infinite complex has been found in the unit of biological activity, the cell. He who hoped for a final solution of the problems of fertilization likewise was doomed to disappointment for the further knowledge has found in chromosomes problems whose physiological action call for new conceptions of attraction and mating seemingly as intricate as the actions of multicellular organisms themselves.

In short, the analogy but suggests the reality so evident to all, namely, the ever increasing contact of known with unknown. Once we had hoped to know, and possibly in its entirety, this or that element of nature. Today, certainly in the more complex aspects and in the world of the ultimate minute, one must accustom himself to unanswered questions on every side. We are more in the presence of mystery and the question mark than man was when science began. If this is one of the characteristics of the science of the future we not only must recognize it but we should also inquire into its effect on the public mind. Like youth we had pushed out on the great conquest, scaling mountains and crossing rivers. The unknown we would know and pushing forward the boundaries of knowledge was our task. What now if the scientist realizes and the public appreciates the fact that we go forward only to find ourselves seemingly ever more remote from our goal. To the scientist this fact argues for an Infinite and an infinity. But from the public a very different reaction may be expected. In terms of the hopes with which science set out, it is failing. Ultimate and complete knowledge apparently is further from rather than nearer to solution. Also if any road we take leads to an interminable maize of complexity, they may question, and rightly so, any one who researches and ask of him whether he progresses but to get lost or whether to bridge gaps and reinforce the already conquered territory. At least with a certain element of doubt and a tendency toward disappointment must the public react as they come to a realization of the increase of the world of unknown through research in a proportion far exceeding the increase of the known.

To summarize the three characteristics of the science of the future drawn from this analogy, we have found the future progress of science will be on the stable base of the already known, adding here more rapidly for a short time, there more rapidly later, but never to be essentially upsetting or spectacular and always to be uncovering more to question than to know, possibly never reaching ultimate knowledge in any element. The effect on the scientist of these characteristics should be to give him confidence in what he does and an assurance of the infinite complexity and wonder that faces him. The reaction of the public must be expected to decrease its enthusiasm and free its interest to be turned into other channels, leaving the worth of any scientific research in the public estimation to be found in a more practical expression than merely extending the boundaries of knowledge.

Another of our men of vision, Professor E. A. Ross, has found in the history of gold mining in California an even more suggestive illustration of the future course of the advance of science. Drawing from his intimate contact with California, he compares the quest of scientific truths to the three stages these mining operations have passed through. There was a time, he said, when he who braved the desert and mountains of the West and through hazard and hardship reached the promised land of California, found gold on the surface. This was the nugget age, to which he compared the period in science when Galileo literally picked up discovery after discovery with his newly invented telescope as he swept it across the Heavens. Edison's work in the field of electricity a half a century ago also represent this stage of science. These men were Forty-Niner's of Science. But the nugget age of necessity must vanish, after which only with sluice and shovel will the earth yield her hidden treasures. Technique was added to the getting of gold and so, too, discovery became more than a mere matter of observation. The tireless patience of a Herschel or the intricate calculations of an Adams is now required to add to the sum of knowlege of the skies. This characterizes the placer age. It is interesting to note that some of the men so wonderfully adapted to discover surface truths in the nugget age fail as only by finer grains and slow accumulation of data truth is wrested from hidden deposits.

No traveler in California but sees the remains of the placer age; deep gullies and broad sluggish rivers tell a story of an age of successful sluice mining. But now even that age has passed; yet California still produces gold. If you seek out her miner of today, he will not be found with pack and mule as nugget hunter, nor with spade and sluice as placer digger but off in some distant office amid blue prints of construction and geological formation you will find him as he figures the cost and profit of the toil of a thousand men and the grind of millions of dollars worth of machinery. He has passed from the category of a miner with courage and pluck to an engineer with science and insight. For years he studied and for years again he laid his plans and raised funds until now his stamping mill and cyanide bath wrests from the solid rock her tiny grains of gold. Even such is the quest for scientific truth in many fields today. This age of the engineer must of necessity come in science: to some subjects sooner, to others, such as Biology, later.

It is discouraging at first glance to see how whole sections of my own subject Physics is passing into the engineering stage. Examples may

be cited in the case of telephony and radio research and all applied work in engines and metallurgy. These fields once were a part of Physics but their value to industry has been so great that they have developed into subjects studied for commercial rather than scientific ends, hence belong now to the field of engineering. In many of the fields of Physics or Chemistry a man working individually with little manual help or financial backing might as well expect to compete with these great industrial and governmental organizations for research as the miner with pan and shovel could expect to stand beside the stamping mill and force of engineers and laborers in gold mining in California today. To be sure there are many fields in which this is not the case now and and the ever widening contact with the unknown, especially in the fields of life processes, may delay the coming of the engineering age in those fields for decades.

If I may sum up the characteristics of science of the future that are suggested by the gold digging illustration, I would mention first the increasing difficulty of research. New fields to be sure are being added and into these we should direct our students. But the theoretical preparation required, the skill demanded, and the financial support necessary must make the research field become more and more restricted except in larger organizations. Still we must not go too far in this prophecy as research today is undoubtedly the highest inspiration the graduate student has and on this basis will be continued. We must rather see to it that we are more discriminating in our direction of that research.

I would prefer to call your attention to the attitude of the public which must be very much changed by the increasing value of commercial and engineering research and the growing difficulties presented to research in pure science. To them the practical will increasingly appear of more value. In view of the possible attitude toward science's failure in the attainment of ultimate truth and the bewilderment due to the increase of the recognized unknown, can one blame the public if it leans towards the practical in science?

That the coming of the engineering age of science is not a thing to be dreaded but rather a bright outlook for humanity may be better seen when we realize the false position scientists have been placed in by the scientific discoveries of the startling kind for the last few decades. This has given discovery an exaggerated value. Pure science is not a thing in itself, any more than the theory of government is. The discovery of the right relations of man to the state is as wonderful

as the discoveries of the laws of electricity; as facts they have value primarily in their use. True, it is inspiring to observe how man can and does discover truth, and it is a part of man's worship to appreciate the wonderful interworkings of nature.

The new age will sanction discoveries largely because of their usefulness. This, however, is not the attitude of the scientist. He has been so overawed by the wonders of creation which he has been discovering to the wondering public that he has taken on a priestly attitude toward himself and a worshipful attitude toward his discovery. While there may be some justification for this attitude on account of the rapid advance of the past and the self-sacrificial work of great men in science, the public will not maintain this attitude. It is not characteristic of engineering. On the contrary the engineering age will depersonalize discovery. By higher salaries it will draw the best men into practical research but their names will not be associated with their discoveries. The public applause will not be courted as it is not necessary to the success of their operations. Increased difficulty and expense and increased commercialism will take romance from discovery. With these changes the focus of the public on the achievement of science will pass, the reverence for the scientist will diminish, and the Age of Science will have passed.

But science will not pass. That is impossible. Rather can we not foresee succeeding this age, an age characterized by a saner view of science? As the most useful of the developments of civilized man, science will stand and on every hand will be demanded. It will be the basis of all operations and of thinking. Its method of analysis will apply tests to all enterprises, whether industrial, educational, or governmental. But the focus will have changed; it will no longer be on science, but on man. It will be a scientific age as no age ever has been: scientific, not because of the glory of science, but scientific because science has been found to be the basis of all activities aimed toward the accomplishment of the ideal of the new age, namely, the efficiency of life. The ideal of efficiency, so characteristic of America's industrial life will become the cry of education, and with it of science; efficiency in health, in intellect, and in the production of wealth.

If I have in any way given a suggestive answer to the first of my questions, namely the Science of the Future, it has been for the purpose of leading up to the message I now attempt to present in this my second question. What should be the Science for the Future? In the first place I wish to note that the members of this Academy of

Science are not responsible for, nor can they change the science of the future. On the other hand, everyone of us who directs the thought and trains the intellect of the youth who are to live in this future is directly responsible for the fitness of their training for conditions as they will be. If science is to be the fundamental basis of all activities of the future, we must teach science and be sure that the science we teach is the science that will be used at that time. We are responsible for the science taught for the future. It is possible for any of us to be teaching a science and inculcating an attitude towards science that will be wholly out of date when these students have attained maturity in their activity and leadership of the state. Undoubtedly our attitude will change; should our teaching not recognize it? We stand today at a critical period in regard to science teaching in our schools; new foundations relative to science are being made, and it is up to the men of this Academy, the very men sitting before me today, to decide what shall be the scientific foundation for the thought and activity of this people. This body of men, carrying the name of science and standing for its progress in so great a commonwealth, should be conscious of their obligations and the imminent demand for action on their part.

Analyzing the present teaching that is laying a scientific foundation in the minds of the future citizens of the state, I would like, if time permitted, to give in full the data from which I have calculated the number of student hours given in all the science courses in the colleges of the state. Giving the results only, it figures out to be eighteen thousand; that is, adding together the number of students attending every class in scientific subjects that meet in all the colleges of the State for one week, it amounts to eighteen thousand student hours. Making the same calculation for all the student hours in science in the high schools of the state the corresponding number mounts to the enormous figure of two hundred and seventy thousand. Comparing these figures the striking fact is seen that, maintaining the present ratio, as much science will be taught in the high schools of North Carolina this year as there would be in all the colleges of the state in fifteen years. In addition I may go further and say that an hour of science taught in the high schools on the average is of more value to the state than a corresponding hour of science taught in college. This is because of the fact that college science is a relatively small element in a broad education embracing some thirty or forty courses, as against the fact that these courses in science given in the first two years to all pupils in

accredited high schools of the state are by count one-fourth of all the education above grammar grades that over half of those students ever get, as half the pupils take only two years of high school. In actual influence I doubt not that it is a considerable fraction of all the real moving education that they get besides their general reading, writing, and arithmetic equipment. All of us may not be acquainted with these facts but the time has come to recognize the fact that science has been placed at the very foundation of secondary education in this state.

If then the foundations of the scientific activities and thought of the future in North Carolina rests more with the science taught in the high schools of the state than with the colleges, what should be the attitude of this Academy of Science toward this science teaching in the high schools? If the purpose of the Academy is to promote science in the state and give every possible assistance to its proper direction, the answer is plain, namely, the Academy should become intensely interested and intensely active in our high school science.

May we not hesitate long enough to get a picture of one of the possible harms science can work when not well directed in high school teaching. There has been a most momentous change in the rural school conditions in this rural state of ours. It may be working a hardship on the parents in many a home. Possibly it is necessary that this should occur, but it doubtless is very real in hundreds of families. Imagine yourself as a young boy or girl leaving a small farm home some winter morning for one of the modern steam heated, electric lighted buildings, such as are now found among our common consolidated schools. From this simple home where there are few, if any modern conveniences,—no water, no central heat or like comforts,—a big comfortable truck picks you up and whirls you away to a fine stone trimmed structure with all one could want of brightness and convenience where you stay enjoying all its advantages throughout the day. At its end, when you are tired, you are hurried back to your little home and life begins again with the carrying of water, filling oil lamps, and shivering with all around a stove or fireplace. But this is home; this is what mother and father gave you. If now you also carry home your intellectural wonders of science that some unthinking general science teacher has laid on thick about how big the sun and stars are, how wonderful creation with its millions of years of change and growth is, and in your youthful enthusiasm you overflow around the supper table with these glorious and rightful

conceptions of the bigness of time and space, what will be the most likely result? Mother and father, who have by their effort worked and saved to make this education with all its outlook possible, but who have been staying by the simple home all day while you are enjoying the environment of comfort and modern life, feel the necessary estrangement. To them this is all new; possibly they do more than appear doubtful and wondering in their effort to believe. Possibly they become antagonistic and the breach between child and parent, already made by the unavoidable contrast of life conditions, may be dangerously widened. The boy and girl conceive of the great world of comfort and science outside their home as being their due right while this is the environment and these are the ideas that those must have who are like father and mother.

How many near tragedies of this kind are being borne by our high school pupils over the state no one can tell. But the question for us is,—is this necessary? In this day of adjustment such as the automobile has brought to the farm home, when boy and girl have the freedom of the roads and little towns, the bright lights of the great cities brought to them by the moving pictures: in this day of no secrets of the social life and temptations ever present in new and most alluring form, can any thinking man do aught that might in any way estrange the boys and girls from their parents, or strain the tie that binds, or lessen the respect that is their proper foundation for love? Possibly the contrast in the physical environment of school and country home is necessary, but who will say that the wonders of science that almost took the breath away from even the best of us as their truth dawned upon us for the first time, should be the choice selections of intellectual food of our first year high school student. We must teach science for the future, but what science and how must it be related to the life they will have in that future?

May I undertake to outline a more fitting approach to science and training in scientific attitude that is the fundamental aim of high school science teaching. The environment of the pupil coming to high school is nature as exhibited in the body of the pupil and in his outside world. To get and maintain health in ones self and to efficiently work and make forces outside us work to produce wealth are the objective aims of scientific instructions. A subjective effect will of necessity come with the proper study of how to do these things; a scientific attitude toward everything and a worshipful wonder are the natural outcomes of the study of the acquisition and use of health and wealth. Nothing

is so stimulating as successful effort, and to this end we educate. But the mothers and fathers of these pupils have been doing just these things as best they knew how for half a century. Without the wonderful direction and interpretations of science they have been seeking health and wealth as the outcome of their activity. Their effort is not to be forgotten nor their success with what they knew to be minimized. Nothing big and nothing startling should be used to begin science work with these pupils. Neither should the heavens above nor the earth beneath in their bigness be the focus. Rather the successful relations of life that are being worked out at home. A survey of the district they live in with simple instruments to note the divisions of fields and soils, of watersheds and topography, of trees and rocks and how they are all used to make life a success by hard working people. Then comes in by degrees the advent of science to explain simple relations of these things and a less evident interaction in the environment, the right interpretation of which means more success in health and wealth and less labor to accomplish it.

Nowhere should science for science's sake be found the motive in high school instruction. Scientific truth for the sake of efficient life as the pupil's parents live it should be the objective of this first approach of the child to the world of discovery and law. With emphasis on the already accomplished success and bravery of his parents the child is made to revere and desire to assist those at home in their struggle. Rather than an estranging and disputing element, that education that science should give the high school boy or girl would produce appreciation, and increased love of the home. It should open up avenues through which the best that science has to give to that home may be carried through the young and enthusiastic child whose most likely future lies in doing what his parents have done, but doing it better and with confidence in the worthiness of such occupation.

But this is not the science of the high school today. Every one of us knows it and the purpose of the first part of this address was to pave the way for the real explanation of why we have given what may often be a stone to those who have asked for bread. We men of science have bowed our knee to the great and mighty science of discovery. To push back the boundaries of the unknown has been our priestly office. But the Sabbath was made for man, not man for the Sabbath must be repeated in this our generation of science worshipers. No higher purpose nor more direct an aim can we take than the pro-

duction of the efficient life. To this end must not only government and industry turn, but science and education. Not to teach Botany or Physics do we bring a child to school but to educate him. By that, so far as high school is concerned, we mean to fit him to live a life successful as to health and to the production and use of wealth and successful as to the proper intellectual activities and aspirations. All of these activities presuppose a complicated environment which the pupil must daily meet, use, and make the most of. When science in high school stops dividing itself into isolated extracts of environment called subjects and worrying itself about the individual completeness of each extract, but rather concerns itself with imparting the ability to live in a complex of actions of nature and succeed with them as they are, it will begin to be a real and most vital element in the educative process found in schools. Such science has not been written in books and such science is not taught in our schools. But such is the science for the future.

To this end, gentlemen of the Academy, I have brought you this consideration of the possible trend of the future with respect to science. You may not agree with me in the prophecies I have ventured to make with respect to the sciences of the future. Naturally that part of my address is speculative and possibly visionary. On the other hand I am confident that you agree with me in regard to the science for the future. We must educate the coming generation of citizens and must thoroughly ground them in science; useful science. To enforce this idea I have tried to show how the application of science will be the characteristic of the future. In the coming age it will be as great to induce people to apply already discovered facts as to discover new truth.

But it is not even to the future that I would direct your attention in closing; it is rather to the immediate problem before this Academy. We as a body have begun to move out into this broader field of service and are offering assistance in every possible way to the proper direction of science teaching in the state. But what we have done is little more than a beginning. We must do more and more of us must participate. The problem is before us and the field is around us. It is our problem; it will not be properly solved without your aid. What type of science, how much of it, and what objectives should be focused on are part of the problem which demands such talent and experience as yours for its solution. We need text books with vision, we need teachers with vision and we need college professors who can give vision to both.

In the high schools of your neighborhood and not in your college is the scientific basis of North Carolina's future being laid. I call on you to make it part of your duty to go to the assistance of those high schools located near you? Take to them some of your spirit and the advantages of your equipment through popular lectures. Will you not learn the problems of those teachers who, possibly as faithfully as you, work to the best of their ability to get science across to their pupils? Get in touch with the State Department of Education that has done more than any one agency to put the knowledge of science in every home. They will assist you and ask your assistance. And when this Academy meets again bring with you as you come, a new enthusiasm for science and a better knowledge of the state's needs learned through participation in a larger way in the cause which we as members of the North Carolina Academy of Science represent. Again I repeat, there is a science of the future and you cannot change it. On the other hand there is a right science for the future. If we have it in North Carolina you must study it, you must test it, you must make it.

STATE COLLEGE,
RALEIGH, N. C.

IMPROVEMENTS IN THE HIGH SCHOOL SCIENCE SITUATION

By J. Henry Highsmith

The Commission on the re-organization of secondary education, in its report entitled "Cardinal Principles of Secondary Education," has set forth seven main objectives of education upon which work in the secondary school should be focused. Science instruction in the high school is especially valuable in the realization of six of these objectives, namely; Health, Worthy Home Membership, Vocation, Citizenship, The Worthy Use of Leisure, and Ethical Character. It is not necessary to enter upon a discussion of these objectives, except to say that science has been insisted upon in the high school to the end that these worthy purposes might be realized.

Prior to the session 1921–22 the teaching of science in the high schools had not been an absolute requirement. At that time laboratory equipment for the teaching of at least two branches of science, namely, General Science and Biology, was required with a suggestion that provision should be made, especially in the larger schools for Physics and Chemistry. In making the teaching of some courses in science mandatory we have secured an emphasis upon this subject that could not have been secured in any other way.

The reports of the High School Inspector for 1918–19 and for the year 1922–23 show the number of students taking the various subjects in Science as follows:

	1918-19	1922-23
Physical Geography	3501	2530
Introduction to Science	6062	9883
Biology	394	4846
Botany	647	223
Physiology	937	681
Zoology	70	88
Commercial Geography	61	581
Physics	1195	1957
Chemistry	624	1938

It should be stated in this connection that the above figures for the year 1922–23 are given for accredited high schools only and for the most part are limited to the four or five state adopted text books most widely used. It is interesting to note the decline in the number of students taking such subjects as Physiology and the rapid increase in the number of students taking Biology. In the session 1918–19 there were only 54 students outside of the city schools taking courses in Biology. Another big increase is the subject of Commercial Geography. The reason for the comparatively small number of students in Physics and Chemistry lies in the fact that the most of the high schools are small schools which have neither teaching staff nor resources to offer courses in these subjects.

Science courses are offered in 574 high schools in the state. The number in any county ranges all the way from one each in Graham, Greene, and Tyrrell to twelve in Alamance, fifteen each in Guilford and Mecklenburg, and twenty-one in Buncombe. There are 706 individual teachers of science in the state. The number employed in the various counties varies from one each in Greene, Graham and Tyrrell to fifteen in Forsyth, twenty-five in Buncombe, and twenty-six in Guilford. Every county has at least one school in which some science is taught.

General Science courses are given in 520 schools; Biology is taught in 327 schools; Physics in 199 schools; Chemistry in 162 schools.

Another evidence of the improvement in the science situation is the amount of money which has been invested in laboratory apparatus and supplies. A representative of one manufacturer lives in Raleigh. His sales alone to the high schools last year were over $10,000. His sales thus far for the session 1923–24 have amounted to $20,000 to $25,000. What other firms have sold in the state is not known.

The average cost of equipment for even a small high school offering two courses is $200. There are 318 standard high schools at the present time with about 75 that will be added to the list at the close of the present session. Three hundred schools at $200 each would be $60,000. Four hundred schools at $200 each would be $80,000. The apparatus and supplies, therefore, in the standard high schools or those that will be standard this year are worth certainly between $75,000 and $100,000.

It is to be admitted that some of the equipment has not been used maximally. This was due to the fact that teachers moved from one place to another, that some teachers could not teach satisfactorily the

courses which had been offered in a given school the year before. I believe, however, that a substantial dividend has been realized on this investment in equipment for the teaching of science in the high school.

In order that science may be taught more effectively and the objectives of secondary education realized more fully, consideration must be given to the following factors:

1. Teachers. Adequately prepared teachers of science are needed. Teachers should be well grounded in the whole field of science and should have specialized in one or two subjects. To be an effective high school science teacher it is necessary that the teacher know science outside of the book and be able to indicate how science may be applied to the life that the child actually lives.

2. Equipment. The equipment prescribed for laboratory work in any one of the sciences is the absolute minimum. It will be necessary to increase this equipment very largely in order that more adequate results may be secured. The purchase of equipment requires first of all a knowledge of what is needed in a given school and second the necessary money for the purchase of the necessary supplies.

3. Laboratory space. In many instances a good teacher of science has been actually handicapped by lack of physical space. Many school-houses were constructed before science teaching, especially laboratory work, was required. Therefore, no room was set aside as a laboratory and on account of over crowded conditions no room is available. It will be necessary, therefore, to make provision in building plans for a laboratory for the teaching of science.

The work in science has been stimulated by the professors of science in some of the colleges. These men have visited high schools, talked with science teachers, talked to students, made addresses to the community, and in every way have sought to increase the interest in scientific subjects. From reports received from principals and superintendents I am prepared to say that the improvement in the teaching of science and in enlarged interest is due in no small measure to the efforts of these teachers of science who have gone from the colleges as representatives of the State Department of Public Instruction.

DEPT. OF EDUCATION,
RALEIGH, N. C.

A NON-MATHEMATICAL INTERPRETATION OF THE THEORY OF RELATIVITY

By W. W. Wood

The Viewpoint

The question as to what is reality has interested mankind since time immemorial. Now Einstein comes along and says there is no use discussing reality, as we can never get rid of the observer's part in observation and discussion, and consequently can never find the absolute.

The old Greeks belonged to the school of Absolutism. They believed they could tap a source of knowledge, pure and absolute, by sitting down in a chair and reasoning about the nature of space and time. To them their concepts were real whether they could identify them with the external reality or not. The necessity of testing the truth by experiment never entered their minds. These philosophers often disputed learnedly why it was that a live fish could be added to a pail brimming full of water without causing the pail to overflow. One day some person decided to try the troublesome experiment and found the pail did overflow.

The word "Absolute" signifies the ability of the mind to subtract the properties and qualities of things from the things themselves. Thus the Socratic mind could talk about absolute space, time, and being. The observer's own part in the concepts of space, time, and being, had nothing to do with it.

Accepting the theory of relativity *in toto* implies that the properties and qualities of things cannot be separated from the things themselves. We are still able to form concepts, but these concepts have their origin in what we actually perceive.

In the revolt against the Socratic mind the pendulum swung too far the other way, and, during the Renaissance, the Classical Scientists, as we call them now, became absolutists in the opposite sense. To them the human mind was relegated to the position of an innocent by-stander. The external reality was everything, and the observer had no share, whatever, in the world of things around him.

Since the time of Aristotle there has been discussed the question whether if the wind blew down a tree at a time and place where there was no conscious being to hear, would there be any noise? The Greek

answered this in the negative because to him the noise was entirely a phenomenon of the listener. The classical scientist answered in the affirmative, because to him the noise was entirely a phenomenon of the tree, air, and ground. Today the Relativist answers it in the negative, but for a reason different from that of the Greek. There is no noise in the presence of the falling tree and the absence of the listener any more than there would be a noise in the presence of the listener and the absence of the falling tree.

From the viewpoint of the relativist, then, the statue is golden to one observer and silver to the other; it is raining in Durham but clear in New York; a certain happening pleases one man and displeases another. The relativist in discussing matters of physical science, must put away everything that smacks of reality. He focuses his attention upon the reports of the senses, and these reports are the only means he has of joining his perceptions to the external things—they afford him his only objective manifestations, and these objective manifestations must be accepted as final.

That it is impossible to separate the observer and the observed is well shown by a comparison of the testimony of several witnesses to the same event. This testimony will differ, and the relativist says that the event was presented to the different witnesses in different ways, and that for each witness his realty was what he observed.

All our information comes from measurements of some kind, and if two observers get different results from measurements of the same thing, the relativist says the observed fact must present different values to different observers, and if there is any reality in the observed fact, we can never know about it. (Of course our measurements are subject to corrections, as the methods of measuring are refined; but this means simply that our "realities are not real, but change as our means of connecting ourselves with the outside world are refined). To any observer his measurements are his external reality. We cannot explain the universe, but simply describe our perceptions of its contents and we must say that our concepts originate in and from our perceptions. Sometime our perceptions give rise to conceptual results that are so foreign to what we consciously or unconsciously perceived, that we are prone to consider the results as having been manufactured in our own minds without regard to the externals.

That Newton regarded time and space as having real existence in the external world is shown by his definition of them: "absolute, true, and mathematical, time flows in virtue of its own nature, uniformly,

and without reference to any external object; absolute space, by virtue of its own nature, and without reference to any external object, always remains the same and is immovable." The relativist says that time and space exist only in reference to the observer.

DEFINITION OF RELATIVITY

The principle of relativity states that every phenomenon of nature is a function of the observer, and that space, time, and motion, can be measured only with reference to the observer—in other words, are relative.

The two postulates laid down by Einstein are: 1. All phenomena of space, time, and motion are relative. 2. The laws of nature are universal—that is, they apply in the same form everywhere; whether in a moving train, on the "fixed" earth, or in the empty space beyond the stars.

SPECIAL THEORY

The special theory of relativity, which is the older, states that all uniform, rectilinear, motion is relative and that it is impossible to tell from measurements made on the system we suspect of motion whether the system is moving or not.

The idea of relativity in a great many ways is familiar to us all. For instance, when we say the velocity of a train is 60 miles an hour, we mean, of course, relative to the rails; but Einstein adds that it makes no difference in our calculated results whether we consider the train as moving relative to the rails, or the rails as moving relative to the train. A person moving in an automobile with a velocity of 60 miles an hour runs into a telephone pole. "There," he says, "you see the result of the absolute motion of my automobile; for certainly my automobile is moving and the telephone pole is not." But suppose the car was being driven in a westward direction (that is against the direction of the earth's motion). Then the telephone pole is actually moving faster than the car, for we must remember that the earth is rotating on its axis towards the east with a velocity of 1000 miles an hour. In addition, the earth is revolving around the sun with a velocity of 18½ miles a second, and is travelling through space, with the whole solar system, with a velocity of 11 miles a second. Who, then, shall say what is the absolute velocity of either the earth or the pole? The relativist says it makes no difference which we consider in motion, or what is the absolute motion of either, for it is the relative motion alone that counts.

Can we even conceive of absolute motion? I believe not; for any conception we have of motion had its origin in our perception of that motion, and we shall all agree that in our perceptions of motion we cannot dissociate ourselves from the motion.

Two trains, A and B, are standing on parallel tracks. There is an observer on train B. Train A has attained a slow uniform motion, and the observer thinks his train is the one that is moving. It is impossible to tell whether it is train A or train B that is moving, unless the observer looks at the station platform. All that the observer can say is that one train is moving relative to the other.

Again, from a moving train a stone is dropped. To the observer on the train the stone drops in a straight line, but to an observer near the track the stone describes a parabola. What is the true path of the stone through space? To one it is a straight line, to the other it is a parabola. We must say that the path can be described only with reference to the observer. There may be a "real" path, but we can never know anything about it. To each observer of the stone his observed path is the real path, and if we know the relative motion of the two observers, the path of the stone as seen by either observer can be deduced from the path as seen by the other.

Einstein's postulate that the laws of nature are universal assumes that the realities of one observer are deductible from the realities of the other, if the relative motion of the two observers is known. This he has accomplished mathematically by what is known as a transformation of axes. For example we shall say that the path of a person walking about inside a moving train has been given with reference to the train; then the path to an observer near the track can also be determined, if the relative motion of the train and track is known; for the same law holds for the path with reference to the moving train, as for the path with reference to the track.

Motion is not the only thing that is relative. We look at a certain piece of cloth by daylight and say its color is heliotrope, but when this same piece of cloth is viewed by the ordinary electric light, its color changes to pink, and under the mercury lamp of the photographer, it becomes blue. If this cloth has any color it is certainly beyond our ability to isolate it.

The examples given above will no doubt appeal to the reason of most of us, but there are some conclusions from the special theory of relativity that are, on the surface, contrary to our common sense.

SPECIAL THEORY APPLIED TO LIGHT

Michelson and Morley attempted in their famous experiment with light to determine the absolute velocity of their laboratory, which, of course was fixed to the earth, and, from it, the absolute velocity of light. Their method is perhaps best illustrated by an example as follows:

Two swimmers, which find they can cover the same distance in the same time, when in still water, decide to separate, one swimming at right angles to a stream 100 yards wide, and the other swimming 50 yards upstream and then 50 yards back. An offhand answer to the question which would cover the 100 yards in the shortest time, would probably be that the times would be equal; and yet a simple calculation shows that the swimmer at right angles to the stream would win. Knowing the velocity of the stream relative to the earth, and the retardation of the time of the up and down trip over that across, the velocity of the swimmer in still water can be determined.

Now in the Michelson-Morley experiment, light was the swimmer and the ether was the water. The velocity of light relative to the earth was known; it was hoped that when the velocities of light at right angles to the earth's motion, and parallel to it, were determined, a difference would be found, from which the velocity of the ether relative to the earth could be determined, and, consequently, the absolute velocity of light in the all-pervading ether. The two arms of the apparatus used were so placed that one was at right angles to and the other parallel to the direction of the earth's motion.

No matter what was the position of the earth in its orbit, the velocity of light came out always the same, and the conclusion from this experiment, and others having the same purpose in mind, is that the velocity of light is always the same, no matter what the velocity of the observer. This conclusion is contrary to common sense; and yet we have to accept it and say that our common sense needs revamping, thus changing our ordinary conceptions—a thing hard to do.

Let us see to what this conclusion actually brings us:

A man standing on a railway track shoots a bullet with velocity (relative to the track) of 2000 feet a second, at a train receding with a velocity of 100 feet a second. The bullet passes the train with a velocity of 2000 minus 100 (1900) feet a second. But suppose this same man lights a lantern on the track behind the train. The light passes a point on the track with a velocity of 186,000 miles a second, and, as

a result of the Michelson-Morley experiment, passes the train with the same velocity—the velocity of light is the same for all observers. This result contradicts not only our common sense, but apparently the theory of relativity.

Einstein explains this by saying that when two observers are in relative motion to each other, the unit of measurement (placed in the direction of relative motion) used by either one, appears too short to the other, and the unit of time of one appears too long to the other. Stated in another way:

When two observers are in relative motion, any distance measured by one (in the direction of relative motion) seems too great to the other and the time elapsed, as measured by one, to the other seems too short. Therefore, the quotient, distance divided by time (which gives velocity) measured by the observer on the moving train seems to the observer on the track to be a quotient, too great a distance divided by too short a time, which makes the velocity of light obtained by the observer on the train seem too great to the observer on the track. To the observer on the track light still passes the train with a velocity of 186,000 minus 100 (185,900) miles a second, but light passes the observer on the train (according to his own observations) with a velocity of 186,000 miles a second—a velocity which seems too great to the observer on the track.

Notice that according to the theory of relativity, the velocity of of light obtained by the observer on the train only *seems* too great to the observer on the track. This condition is entirely a concept of the mind, and has no reality—in fact, according to the theory of relativity, we cannot determine the reality of the velocity, and the velocity determined by either observer is his reality. The velocity of 186,000 miles a second is just as real to the observer on the train as it is to the observer on the track. The difficulty lies in the virtual impossibility of the observer on the track forming the concept of what happens to the observer on the train.

The best explanation of the above contradiction that the author of this paper has seen is by Jeans, who says "no matter what the velocity of the observer is, the light surface, as observed by that observer, is invariably a sphere having that observer as a center." This statement means that the wave front of light is a contracting sphere with the observer always at the center, and makes light entirely a subjective phenomenon. As Pickering puts it: "the velocity of light with regard to the ether is a variable quantity, depending merely upon where

the observer chooses to go"; and with Eddington: "these relations" (of light) "to the ether have no effect on the phenomenon, and can be disregarded—a step which appears to divest the ether of the last remnants of substantiality."

We shall explain, then, the fact that the velocity of light is the same for all observers, in this way: light is entirely a subjective phenomenon; the velocity of light can be anything, and so adjusts itself that it always has the same value.

When we state that all units of distance and time used by one observer, in relative motion to another, seem to the second observer to change values, we must remember that these changes can never be actually observed and measured by the second observer. For example, if everything in the world should suddenly be increased 100-fold, including the observer and all his sense organs, no difference whatever would be manifested. This condition can be conceived but not perceived.

No distance, then, has a definite meaning, and all measurements must be considered as relative to the observer. Euclid's geometry of absolute space has to give way to a different geometry, since the attempt to isolate absolute space will always fail.

General Theory of Relativity

Einstein, not content with the relativity of uniform, rectilinear, motion, generalizes the special theory, and states, in the general theory that there is no such thing as absolute space, time, or motion of any kind.

Relativity of Mass

We have already seen from Einstein's explanation of the behavior of light, that if a body is moving rapidly past us, the distance appears shortened and the time lengthened. Therefore the velocity appears slower.

Now the energy of a moving body depends upon the product of its mass and velocity. Hence, with the same energy put into a body, if the velocity appears slower, the mass must appear larger, and we find that mass is a variable thing depending upon the velocity. It follows, then, that it is only the product of mass and velocity that remains constant, and the greater the velocity of the body the more it appears to be slowed down, with the consequent appearance of increase of mass. The result is that mass appears to increase with velocity.

This variability of mass is not noticeable with ordinary velocities. But the velocities of the so-called electrons in the vacuum tubes of the large wireless station approach 100,000 miles a second, and it has been known, (though unexplained till now) that the mass of these electrons increases with their velocity. This change of mass, with velocity, then, admits of experimental verification.

UNITY OF GRAVITATIONAL FORCE AND ACCELERATION

In Newtonian mechanics there are two kinds of forces—the fictitious centrifugal force and the "real" gravitational force. Einstein has shown that the cause of these two forces is the same, and that neither is a real force, but only the manifestation of accelerated motion.

A speck of mud on a rotating buggy wheel flies off in the direction of the tangent to the periphery of the wheel. Newton realized that there is no real force here, but that the phenomenon is only a manifestation of inertia—that is, the speck of mud had a given velocity at the time it ceased to stick to the wheel, and it kept the same velocity after it left the wheel. All bodies according to Newton, continue in a state of rest or uniform motion unless acted upon by some outside force. The speck, then, follows the same path it would have followed had some force projected it in the direction tangential to the rim of the wheel, but this path is only a manifestation to the observer of the effect of the relative motion of the speck and wheel. To an observer on the wheel (partaking of the same acceleration as the wheel) the path would appear curved. It was recognized by Newton that centrifugal force was not a real force, and that gravitational and centrifugal forces both depended upon the same thing—that is, the inertial mass of the body under consideration, but he did not understand that the two forces were in all respects the same, and that they were simply the manifestation of accelerated motion.

Imagine a billard table placed on the floor of a train standing still on a perfectly level track. Now place a ball in the centre of the table. As the train begins to move (that is accelerate) the ball moves toward the rear of the train. To an observer on the train the ball is pulled backward by some force (that is, "falls" toward the back of the train), but to an observer on the track the ball does not move at all, but the train moves forward under it. We thus see that to the observer on the train the motion of the ball is a manifestation of the train's acceleration and appears as a force acting on the ball, but to an observer outside the moving system, the motion of the ball is according to Newton's

law of inertia—the ball stays where it was put, and the train slides under it, thus accounting for the motion of the ball by giving the train the proper acceleration.

Again, consider the train standing on a grade where the front end is higher than the back. Now place the ball on the centre of the table. To the observer on the train the ball moves (that is, falls) towards the back end of the train just as if a force were acting in it. The path of the ball is the same as in the case where the train was considered accelerated, and the actual motion of the ball can be accounted for by giving the train the proper acceleration. Now what impression does the observer on the track get in this case? It is evident that the observer on the track gives the same interpretation to the phenomenon as the observer on the train. Therefore when the train is inclined both observers think the ball is acted upon by some force. This is as it should be according to the theory of relativity because both observers have the same motion (that of the earth)—that is, are in the same gravitational field—and neither is conscious of his acceleration. The general theory of relativity states that the observer cannot tell whether he is in motion or not, if he limits his observations to his own moving system.

If this is the case, why is it that an observer sitting on the seat of a train experiences a force pushing him against the back of the seat when the train begins to move? The answer is that this force is simply a manifestation of the acceleration of the train, and can be accounted for by giving the train the proper acceleration.

We thus see that the gravitational pull of the earth is simply a manifestation to all observers on the earth of the earth's acceleration, but that to a super-observer outside the earth there is no force present, and he interprets the phenomenon of the falling body as a sliding of the earth under the body. So the motion of any object, manifested to us by a force, can be accounted for by giving the proper acceleration to the system relative to which the object is moving.

A person falling freely through space would experience no force at all, but to an outside observer a force is apparently the cause of the falling. A billiard ball can be considered as falling toward the back end of the train with just as much propriety as a stone falling towards the earth.

The Path of a Falling Object

Falling, then, is simply the way in which the path of the object falling is manifested to us, and is nothing more than the effect of the

earth's acceleration. In empty space, far beyond all matter, a body falls forever, and the direction of its path is the Euclidean straight line. But all of the paths we observe are in the neighborhood of matter and these paths are manifested to us as curved. The natural path (the one the object seems to the observer to take) is what Einstein calls a Geodesic; and these geodesics, in the presence of matter, are curved. The geodesic of a planet revolving around the sun is ellipse, and this path is the same as it would be if we considered the planet as falling continuously toward the sun. If all matter except that in the planet under consideration could be suddenly obliterated, then the path of the planet would immediately become a Euclidean straight line through space.

SPACE PERCEPTIONS

Up to the time of Einstein, space had been considered as absolute, and the paths of objects moving through it as variable. For each object a different equation was necessary to adequately describe the appearance of the path to the observer. From a mathematical stand point it is easier to consider space as having such a curvature that the paths of objects moving through it will be that of the shortest distance between two points in this space. Then, only one equation will be necessary to describe the paths of all objects through space, for this equation by a transformation of axes will fit all cases.

For those who, are not familiar with what is known as a transformation of axes, we might refer to the example of the train and billiard ball. When we said in that example that the motion of the ball could be accounted for by considering the train's motion as accelerated, we were actually using a transformation of axes, for we transformed the observations of the observer in the train to a new system with reference to which the train had an acceleration. As long as the observer on the train confined his observations to the train, which had the same acceleration as he, there was no evidence of the train's motion, and the motion of the ball was as if a force were acting on it, but as soon as he transformed his axes so that the train was moving with reference to them, he accounted for the ball's motion by giving an acceleration to the train. This transformation, of course, is conceptual only, but admits of great simplification in the mathematical formula.

Thus, instead of considering space as Euclidean, that is, fixed and immovable, and the paths of objects variable, we prefer to consider space as curved, and the paths of objects fixed with reference to the matter filling space.

It is said that the mathematician is the only one who does not care whether his conclusions are true. He makes a distinction between true (that is, agreeing with experience) and correct conclusions. A proposition in geometry is correct if it follows by logical reasoning from certain assumed axioms, but it may not be true, that is, it may not agree with our experience, if our axioms are false. Euclid's geometry depends entirely upon what he assumed in the beginning as axiomatic, and all his propositions stand or fall with the truth of his axioms. For many years Euclid's geometry agreed with our experience, and was consequently considered true, but as our knowledge increased we began to find that certain of his propositions were not true—that they did not agree with our experience. Now Einstein, by accepting certain axioms of his own, has built up a different geometry, and his conclusions so far are not only correct, but true. Of course it is possible that in the future Einstein's conclusions may be shown to be untrue, but, for the present, we must accept them as both correct and true.

It might be said that Einstein was not the first to use a geometry different from that of Euclid, but he took from these non-Euclidean geometries, built up by others, what he needed to account for the facts as observed up to the present.

GEOMETRICAL CONCLUSIONS FROM THE GEOMETRY OF CURVED SPACE

1. The sum of the angles of a triangle is not equal to, but greater than, 180°. There is nothing startling in this statement because, since the time of Euclid, it has been known that the sum of the angles of a spherical triangle is greater than 180°. Whether the sum of the angles of a triangle is equal to, greater than, or even less than, 180°, depends upon what kind of surface we are considering.

2. The ratio of the circumference to the diameter of a circle (equal to π, 3.1416) does not hold in the geometry of space where gravitational force is exerted; that is, where matter, and, consequently, the acceleration of matter, exists. In the gravitational fields of space, the observer and the bodies being measured, partake of the same acceleration. This acceleration is radial. Now try to measure the circumference and diameter of a given circle. The circumference, being at right angles to the acceleration, is unchanged, while the diameter is lengthened. Hence π comes out less than 3.1416. (Compare B's attempts to determine the velocity of light relative to the moving train on which he is stationed.)

3. Any two straight lines intersect each other.
4. There are no parallel lines.
5. There are no infinitely distant points on a straight line.

Conclusions 3, 4, and 5, are just as true in the geometry of the sphere as in Einstein's elliptic geometry of space. When we say that any two straight lines intersect each other we mean by straight lines the geodesics, or natural paths of objects in space, which correspond to great circles on a sphere.

Since there are no parallel lines, but all lines intersect, it follows that the geodesics of all bodies moving through space return upon themselves, and we can thus, say that our universe is both boundless and finite. This conception is clear when we remember that the surface of sphere is both boundless and finite.

TIME AS THE FOURTH DIMENSION

We shall all agree that all measurements of time depend upon measurements of distance. When the earth has made one revolution on its axis, a point on its surface has travelled 25,000 miles. But we also say that 24 hours of time have elapsed. Thus we can say that 24 hours of time is 25,000 miles, and we can find in miles the equivalent of one hour's time, and, with the proper choice of our time unit, time and distance become the same. Again, if a train has a velocity of 60 miles an hour, we can say that between two observations, the train has moved 60 miles, or, with equal propriety, one hour; and, in the last analysis, time and distance may be used interchangeably.

Again, we have seen that distance is a variable quantity; therefore time is also variable, and we can no more measure absolute time than absolute distance.

A great many persons are bothered by the conception of a fourth dimension. When the mathematician speaks of a fourth dimension it is usually taken to be time. Time as a fourth dimension, means simply that if a proper unit of time is employed, it can be used in equations on a parity with distance. When, in physics, we say that distance equals velocity multiplied by time, we are, in fact, already making time and distance one.

We have three directions at right angles to each other in which we may measure distance, illustrated by our right and left, back and front, and up and down. These three ways of locating a point in space are referred to by the mathematician as coördinates, and we thus say that space is three dimensional. But we are also aware that it is necessary

to know the time when a body is in a certain position before we can definitely locate it in space. For example, we can locate a certain building by knowing its distance north or south of the earth's equator (the latitude), east or west of Greenwich (longitude), and its elevation above sea level; but suppose this building were located by these three directions or coördinates alone. At some future date it would be impossible to tell where the building was in space, for our origin of coördinates is continually in motion, and to find the location of the building it would be necessary to know how it moved in time. This change of position with time is in the fourth dimension.

The difficulty with time as a fourth dimension will be removed if you will remember that it is impossible to perceive a fourth dimension, but that this fourth dimension can be conceived as an extension of the third dimension, just as the third dimension is an extension of the second dimension. If nothing had thickness it would be impossible for us to conceive a third dimension.

We have always used time in our equations, but have accustomed ourselves to thinking of it as entirely different from the three coördinates x, y, and z. Just as, using the proper units, we can connect x, y, and z, in one equation, so, using again the proper time unit, we can connect x, y, z, and t, in one equation, and we can treat the resulting equation in four variables just as easily as one of two or three. But we cannot perceive the fourth dimension of space like we can the three dimensions. The conception of the fourth dimension offers no difficulty to the mathematician, though he can no more perceive it than anyone else.

Coincidence of Certain Observed Results and Those Predicted from the Theory of Relativity

1. The velocity of light is the same for all observers. This fact, as shown by the Michelson-Morley experiment, really antedates the theory of relativity, but follows once this theory is stated. To an observer moving with the velocity of light, time stands still. The velocity of light is the maximum possible velocity.

2. The mass of a body increases with its velocity. The electrons in the vacuum tubes of a wireless station show a measureable increase of mass.

3. Mass and energy are the same. We know that energy increases with the velocity. If then mass and energy both increase with velocity, then mass is just a manifestation of energy.

4. The discrepancy between the observed and predicted advance of Mercury's perihelion is accounted for. It has long been known that the perihelion of the planet Mercury actually moves faster than it should according to Newton's law of gravitation. (In a planet's orbit around the sun the perihelion is the point nearest the sun, and this point according to the law of gravitation should continually advance in the direction in which the planet moves in its orbit.)

According to the theory of relativity the observed velocity of Mercury in its orbit is less than it would be if measured by an observer on Mercury. Therefore, if Mercury has a greater velocity than that observed, the perihelion should advance faster than the heretofore computed amount. The theory of relativity accounts for this discrepancy between the amount computed by Newton's law of gravitation and the observed amount; but, according to the astronomer Pickering, the agreement is "too good," as the computed amount depends upon certain assumptions that are impossible of verification.

5. The curvature of a light ray in passing near a large body like the sun is accounted for. Since light has mass it should behave like any other matter. Now all geodesics are curved in the presence of matter, therefore light should show a curved path when passing near a large body like the sun.

The path of light has been tested during solar eclipses and found to be curved. The theory of relativity predicts the amount of this curvature, and, although all observational results are not entirely in accord with the predicted results, the evidence seems to be that the two agree within the limits of observation.

The conception of the curvature of a light ray as it passes near the sun can, perhaps, be illustrated by an analogy.

Imagine a pond of water, the surface of which is perfectly still. Now place a small object on the surface, and, by blowing on it, continuously in one direction, the object will float across the water in a straight line. On the surface of the water at a point near the path of the object, place a small particle, which, not being heavy enough to sink, yet causes the water surface to sink a little in the neighborhood of the particle. The surface of the water, then, near the particle deviates from what is practically a plane, and takes a somewhat hemispherical shape with the particle at the centre.

Now, as soon as this floating object reaches the bent water surface, it deviates from a straight line, and the direction of the path beyond the bent water surface is no longer the same as it was before it reached

the depression. That is, the path of the floating object curves in going across the part of the water surface in the neighborhood of the particle. This curved water surface corresponds to curved space.

6. There is no need for an ether. In the past some have considered ether with motion, and others without, but no one has known just what it is. If the ether stands still and the earth is moving through it, then the observed velocity of light would vary according to the direction in which the earth was moving through it. This is contradicted by the Michelson-Morley experiment. If, on the other hand, the ether moves with the earth, then the velocity relative to the earth should be the same no matter how fast or what the direction of the earth's motion. This hypothesis of a moving ether fits in with the Michelson-Morley experiment, and the theory of relativity, but is contradicted by the phenomenon of aberration of a star's orbit, which is an observed fact, and calls for a stationary ether. (The phenomenon called aberration is simply that, due to the motion of the earth in its orbit around the sun, the stars describe (appear to describe) little paths similar to the earth's path, just as a street light appears to move as an observer passes it.)

We thus see that we can prove experimentally that the ether both moves and does not move. The only way out of this paradox is to abandon the thought of an ether. The ether never has been necessary for electro-magnetic waves, and, since the light wave has been proved to be of the same nature as the electromagnetic wave, we do not need the ether for light transmission. As Steinmetz puts it: "whatever may be the mechanism of the electromagnetic wave, it certainly is not a mere transverse wave motion of matter, and the light, being shown to be a high-frequency electromagnetic wave, cannot be considered any more as a wave motion of the ether." Since, then, light is not a wave motion of matter, we must look in another direction for its explanation. We have carried this explanation of light waves back to the same source as that of the electromagnetic waves—that is, to energy storage in space—and that is as far as it can be taken.

"All sense perceptions are energy effects." Therefore since all knowledge comes from our perceptions, and all our perceptions are energy effects, we conclude that energy is the only real entity, and space and time are only the forms in which the human mind conceives this energy. In other words, we perceive energy but conceive space and time, which are not absolute in themselves, but relative to the human mind.

In conclusion, it might be said that Newton's laws give such close approximations to the results obtained from Einstein's theory of relativity that the difference can be noticed in but very few instances to date, and, where a difference does manifest itself, is so small that it is hardly measurable.

The only laws that will need recasting for practical results under the accuracy of observation attained at the present, are those in which occur velocities of a magnitude approaching that of light.

The practical result of the theory of relativity lies in a better understanding of nature, and its so-called laws, rather than in the changes brought about in those laws as stated by Newton.

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NEW MEGACHILID BEES

By Theodore B. Mitchell

Unless otherwise stated, the material upon which these descriptions are based was collected by the author. Two of the descriptions are of unique specimens which were collected some years ago in this state. They were found among the unidentified material in the collection of the State Department of Agriculture when the survey of the bees of the state was started.

I wish to acknowledge here the assistance of Mr. J. C. Crawford whose suggestions and criticisms have been helpful.

In making these descriptions a simple binocular microscope with 6× oculars and 40 mm. objectives was used.

Megachiloides n. g.

Closely allied to *Megachile* but the tongue is very long, being more than half the length of the entire insect, and at rest is carried beneath the thorax between the coxae instead of being retracted beneath the labrum. The first, third and fourth joints of the labial palpi are about normal in length for *Megachile*, but the second is nearly four times as long as the first. The third and fourth are minute and similar to each other. The maxillary palpi are three-jointed, the first and second joints having the length and breadth subequal, the third being the longest, distinctly narrower at the base than the second and quite strongly tapering apically. The mandibles of both the male and female are tridentate. In the female the apex is broad, the two outer teeth are approximate and strong, there is a notch on the inner side of the second tooth (sometimes obliterated in worn specimens) and the wide space between the second and third is occupied by a bevelled cutting edge. In the male the apex is narrow, the middle tooth being the least prominent, and there is a strong basal inferior tooth as in *Megachile*. In other characters it agrees with *Megachile*. In the length of the second joint of the labial palpus the tongue resembles that of *Lithurgus*.

Megachiloides oenotherae n. sp.

Female: Head as broad as the thorax; clypeus closely punctured, the apical margin with two small lateral emarginations, the intervening

space being somewhat elevated and sometimes with a small median emargination, thinly pubescent, the pubescence pale, tending to ochraceous below; mandibles striately punctate, somewhat reddish, with a fringe of long, light hairs below, the two outer teeth approximate and strong, the space between the second and third occupied by a bevelled cutting edge; labrum broad, truncate, smooth, almost impunctate; cheek fairly broad, shining, punctures rather sparse below, closer above, with thin, light pubescence, long below; vertex closely punctured, with black pubescence, this encroaching on the upper part of the cheeks and extending slightly below the ocelli; occiput behind vertex with light pubescence; front below ocelli shining and more sparsely punctured; supraclypeal plate closely punctured; long white pubescence on inner orbits and surrounding antennae; antennae black, flagellum obscurely reddish, scape with short black hairs, third joint longer than second or fourth, the apical one nearly twice as long as the subapical joint.

Thorax closely punctured, finely tessellated between punctures on the mesonotum; pubescence mostly white, black on mesonotum except anterior and lateral borders, and largely black on scutellum; tegulae dark, somewhat reddish, closely and finely punctured; wings slightly dusky, more so apically, nervures dark, recurrent nervures entering second submarginal cell at about equal distances from base and apex, basal nervure beyond transverse median; legs black with light hairs, that on the under side of the tarsi and to a less extent, of the tibiae, yellowish, apex of front tibia strongly, broadly produced, smooth and shining; claws simple; tibial spures pale testaceous.

Abdomen broad and rather flat, the basal segment with a large impunctate concavity having a definite margin but hardly carinate; segments 2–4 rather broadly and deeply depressed basally and to a less extent apically, punctures close and fine; segments 2–5 with apical fasciae of light pubescence, the disk of each with short black pubescence; the first segment is fasciate on the sides, and the pubescence is entirely light, long laterally; the sixth dorsal segment is concave when viewed laterally, with short black pubescence, a tuft of long black hairs on either side of the segment at base, visible from above; scopa white, black on last segment. Length 10–11 mm.

Male: Head as broad as thorax, with dense white pubescence, directed downward on clypeus and entirely hiding the surface, directed upward on the supraclypeal area and outwardly on the inner orbits; mandibles shining, impunctate on outer and apical edges, else-

where striately punctate, basal inferior tooth acute, apex shining, impunctate; cheeks and vertex as in female; antennae black, joints 3 and 4 shorter, hardly longer than wide, apical joint about twice as long as wide, the others being about one and a half times longer than wide.

Thorax, tegulae and wings as in the female, except that the recurrent nervures are received closer to the base and apex of the second submarginal cell; legs black with white pubescence; front coxae with strong, abruptly pointed spines, these with long white pubescence posteriorly front femora produced below, almost carinate, smooth shining and reddish on inner side, closely punctured, with long white hair on the outer side; front tibiae obscurely reddish, apex produced to the normal spine; first tarsal joint dark, becoming lighter apically, slightly dilated and thickened so as to be three-sided, the outer side flat, the anterior side strongly hollowed out, and the posterior side slightly so; second, third, and fourth joints whitish, dark on apical and lateral margins; tarsi of front and middle legs with strong posterior fringes of white hairs; middle and hind tarsi dark; claws red, cleft at apex.

Basal segments of abdomen much as in female, but with the pubescence of the second mostly light; carina of sixth segment entire, triangular, rounded at apex, apex of segment with a prominent carina on either side of the middle and an inconspicuous dentiform angle on each extreme side; apex of seventh segment sharply, triangularly produced. Length 8–10 mm.

This is apparently oligotropic on flowers of *Oenothera*, most of the specimens having been caught on *O. laciniata*. Females caught on other flowers have no pollen in the scopa.

The type specimens will be deposited in the National Museum at Washington.

Caught at Raleigh during May. One male caught at New Bern, N. C., on May 16.

Oligotropus wilmingtoni n. sp.

Female: Head subequal in breadth to thorax, with large, deep, well separated punctures, the surface between the punctures shining; pubescence white, rather long and thick between antennae and on inner orbits, elsewhere thin; apex of clypeus with a deep median quadrate emargination, on either side of which it is distinctly tridentate; mandibles 4-dentate, striato-punctate, with a sharp tubercle extending from apical tooth to basal tubercle, this interrupted medially; antennae reddish below, black above, scape and pedicel black.

Thorax with large deep punctures, confluent on pleura, well separated on mesonotum and scutellum; with thin short white pubescence, dense before tegulae around prothoracic spines, on upper lateral faces of propodeum, and a small patch behind tegulae on lateral corners of scutellum; punctures of sides of propodeum fine and close; tegulae fuscous, shining, with fine punctures; wings strongly infuscated, more so apically, violaceous, second recurrent nervure entering second submarginal cell nearer to apex than the first recurrent to base, basal nervure beyond transverse median; legs black with white pubescence, yellowish beneath tarsi; claws simple; tibial spurs pale yellow.

Abdomen with strong punctures, deeper laterally, well-separated throughout, sparse in centers of segments 3 and 4; segment 1 with the usual impunctate concavity, with a short dense apical fascia at sides, finely punctured, closely so at sides; segments 2–4 constricted basally, the constrictions with white pubescence, and the segments with apical white fasciae, sub-interrupted in middle; segment 5 slightly constricted medially, not fasciate; segment 6 confluently punctured, with short subappressed pubescence, mostly light, with some slightly longer dark hairs; scopa white, black on apex of last segment; with the exception of the last segment the pubescence is entirely light. Length 11 mm.

Male: Clypeus more sparsely punctate above than below, the punctures being fine and close below; apex of clypeus largely hidden by white beard, but with three tubercles, a median inconspicuous one, and on each side of this a lateral shining and rather prominent one; mandibles with the usual inferior medial tooth, otherwise three-dentate; flagellum obscurely reddish below, darker above, scape and pedicel darker.

Thorax as in the female; front tarsi somewhat dilated, the first three joints polished beneath; claws cleft; spurs pale testaceous.

Abdomen shining, with deep well-separated punctures; the segments with the basal depressions and fasciae as in the female; apical margins of segments hyaline, rather broadly so laterally on 2 and 3; sixth segment with a low inconspicuous carina, broadly emarginate medially; apex of segment with two pairs of spines, the extreme lateral pair rather sharply pointed, the inner pair broad and flattened.

This is easily separated from the others of this group by the color of the wings, but otherwise it is hard to distinguish from *campanulae*. From *exilis* it is separated in having a median emargination on the apex of the clypeus and in not having a fascia on segment 5. From *cam-*

panulae it is separated by the color of the wings and the larger size, as well by the crowding of the punctures on the pleura, these usually being well separated in *campanulae*.

The types will be deposited in the National Museum.

Caught at Wilmington, N. C. Aug. 2, 1921 and July 10, 1922, on flowers of *Strophostyles* sp.

Megachile aspera n. sp.

Female: Supraclypeal plate shining and almost impunctate medially, closely punctate laterally; clypeus closely punctured laterally, more sparsely so medially, shining, apical edge smooth and shining, unevenly and finely crenulate; mandibles somewhat reddish at tip, 4-dentate, with rather coarse and close striate punctures; cheeks shining, quite strongly and evenly punctured, punctures distinctly separated below, contiguous above; punctures of vertex well separated, those below level of ocelli crowded; pubescence of face and cheeks light, on vertex mostly dark, extending forward on front below level of ocelli and medially nearly to insertion of antennae; scape black, flagellum obscurely reddish, terminal joint almost twice as long as broad, the others slightly longer than broad, subequal in length.

Thorax with pubescence light, except for dark hairs on mesonotum and scutellum; punctures sparse and scattering in center of mesonotum, finer and close anteriorly and laterally; scutellum somewhat more closely punctured; tegulae obscurely reddish, with fine punctures anteriorly, nearly impunctate posteriorly; wings lightly infuscated, darker along costa, nervures dark: legs black with light pubescence, that on tarsi beneath ochraceous.

Abdomen shining, punctures very fine and sparse, very much so basally, the first segment being almost impunctate above; pubescence of first segment entirely light, long laterally, that of disks of segments 2–5 very short and black, these segments evidently fasciate (specimen very badly rubbed), terminal segment with golden pubescence, largely appressed, but with numerous erect golden hairs; segments 2–4 with rather shallow transverse basal depressions; scopa ochraceous, light on terminal segment. Length 9 mm.

This may be *exclamans* Vier., although in this latter species the mandibles are described as being 5-dentate and the apical dorsal abdominal segment as having some erect black hairs. In *aspera* the mandibles are 4-dentate, but the inner tooth with a very slight indication of an emargination tending toward the 5-dentate condition, and the pubescence of the apical dorsal segment is entirely light.

The type is in the collection of the State Department of Agriculture, Raleigh, N. C.

Caught at Jefferson, N. C. in September 1912 by C. L. Metcalf.

Megachile rubi n. sp.

Female: Clypeus evenly, closely and strongly punctured, the apical edge smooth and impunctate, slightly incurved and with indistinct crenulations; mandibles 4-dentate, reddish apically, shining, with sparse striate punctures on upper surface, more closely and finely punctured on outer surface; labrum truncate, very finely rugose; malar space none; cheeks fairly broad, evenly punctured, punctures shallow and close, fairly large, pubescence white; vertex punctured similarly to cheeks, pubescence black, extending in front of lateral ocelli, a fringe of white pubescence surrounding the anterior ocellus; punctures between lateral ocelli and eyes well separated, surface shining; front closely punctured; pubescence of face directed upward between antennae, outwardly on inner orbits, inwardly on supraclypeal plate, all white with the exception of a few black hairs intermixed with the white between antennae; basal joints of antennae black, flagellum obscurely reddish below, black above, joint 3 longer than 2 or 4, 4 slightly broader than long, length of the others gradually increasing to the apical one which is about twice as long as broad; tongue rather short; maxillary palpi 3-jointed, joint 1 short and robust, joint 2 a little longer than broad, 3 narrower than 2, more than twice as long as broad, rounded apically, with a short apical seta; joints 1 and 2 of the labial palpi subequal in length (about 1 mm. each), joints 3 and 4 slightly dilated apically, about twice as long as broad.

Thorax with pubescence mostly white, black on mesonotum with exception of anterior and lateral borders, a few black hairs intermixed with the white on scutellum; punctures on mesonotum somewhat scattered in center, close laterally, surface finely tessellated, shining; punctures of scutellum well separated at least in middle, surface more shining; punctures of pleura close; tegulae dark, tinged with red, with fine, well separated punctures and with an anterior patch of white pubescence; wings faintly dusky, apical margin slightly more so, nervures fuscous, recurrent nervures entering second submarginal cell at equal distances from base and apex, this distance being short, basal nervure beyond transverse median; legs black, with white pubescence, yellow on under side of tarsi; middle metatarsus nearly as long and broad as its tibia, the two following joints dilated; hind metatarsus

likewise almost as broad as its tibia, much more thinly pubescent than the middle one; claws red, simple, each with a blunt basal tooth.

Abdomen smooth and shining, with scattered small punctures. the dorsal segments constricted basally; segments 2–5 with narrow apical fasciae of white pubescence; pubescence of basal segment all white, conspicuous on sides where there are short apical fasciae; pubescence of second segment mostly white, with a few black hairs intermixed; disks of segments 3–5 with black pubescence, longer on sides; segment 6 slightly convex in outline when viewed laterally, distinctly triangular when viewed from above, the sides flattened, making it beak-like in shape, the pubescence on the ridge of the beak black and appressed, that on the sides apically, white and appressed, with scattered erect black hairs laterally; scopa white, black on apical and lateral margins of 5th and entirely on 6th; basal segment with the usual impunctate concavity. Length 12 mm.

The type is in the collection of the State Department of Agriculture, Raleigh, N. C.

Two specimens caught at Raleigh, May 8, 1922, on flowers of *Rubus*.

Megachile negleca n. sp.

Male: Breadth of head and thorax subequal; pubescence of face white, dense below, thinner above, especially above ocelli; mandibles shining, somewhat reddish, straito-punctate, sparsely so on superior face, closely and finely so on outer face, with a basal inferior tooth; cheeks fairly broad, broadest just above middle of eye, rugose, but not strongly so, with rather thin white pubescence; vertex shining, punctate, punctures irregularly spaced, mostly well separated, pubescence light except for a few dark hairs just above summit of eye; scape of antennae with white pubescence, flagellum brown below, blackish above, joint 4 hardly longer than broad, subequal in length to 3, the following joints distinctly longer than broad, the terminal one the longest, flattened and slightly dilated, shining on upper surface.

Thorax well punctured, closely so on pleura and sides of mesonotum, rather sparsely so in center of mesonotum, surface between punctures very finely tessellated but shining; scutellum with a median impunctate area, otherwise being quite closely punctured; pubescence quite long, white except for some dark hairs on disk of mesonotum; tegulae red, punctures very small and inconspicuous; wings slightly infuscated, nervures reddish, recurrent nervures entering second submarginal cell very close to base and apex (nearly interstitial except for the second

recurrent in right wing which is well before apex of cell), basal nervure beyond transverse median; legs with white pubescence; front coxae dark, nude, shining and sparsely punctate in front, with large flattened pointed spines which are also bare in front, the coxae and spines with long white pubescence behind; front femora three-sided, the anterior face yellow except for the dark border, the upper face testaceous basally, the anterior border and the apical third dark red, the posterior face black, with long white pubescence; front tibiae also three-sided, the outer face punctate and pubescent, black except for the cream-colored apex, the two inner faces yellow or testaceous, merging into the black of outer face; front tarsi cream-colored, somewhat dilated; the four posterior legs black, tinged with red, especially tarsi, middle tarsi slightly dilated; claws cleft, testaceous, darker apically; spurs pale yellow.

Abdomen shining, punctures rather fine, well separated; segment 1 with long white hair, subfasciate on sides apically; segment 2 with hair white (a very few dark hairs near apical margin) and with an apical fascia, more dense laterally; segments 3–5 with hair of disks largely black, with white apical fasciae; segments 4 and 5 with appressed white pubescence basally; segment 6 with a pointed triangular carina, slightly irregularly serrate on either side, the disk of the segment above the carina with appressed pubescence and also with long erect hairs, all white, pubescence below carina white and dense, the apex of the segment carinate, this carina rather broadly produced on either side of middle and laterad of these on each extreme side of the segment a small dentiform angle, but no distinct tooth; segment 7 produced into a conspicuous triangular spine. Length 8 mm.

The type is in the collection of the State Department of Agriculture, Raleigh, N. C.

One specimen, caught at Raleigh, May 8, 1922 on flowers of *Rubus*.

Megachile audax n. sp.

Male: Face with pubescence whitish; mandibles black, reddish near tip, with a strong inferior basal tooth, the inferior edge of the mandible rather strongly angulate medially, mandibles viewed from above quite regularly rounded; cheeks closely and finely punctured, with pubescence thin above, a dense white patch on lower angle, and just beyond this patch a strong hollowed-out scale which receives the inferior mandibular tooth, the outer edge of the scale fringed with ochraceous pubescence; vertex with punctures more distinctly separated

than on the cheeks, some short dark pubescence just behind and above eyes; antennae dark; scape with thin light pubescence, joints 3 and 4 subequal in length, 5 and following joints somewhat longer, terminal joint the longest, dilated and flattened.

Pubescence of thorax entirely whitish or cinereous; mesonotum closely punctured; tegulae obscurely reddish, distinctly punctured; wings subhyaline, somewhat darker apically, nervures dark; front coxae with strong flattened triangularly pointed spines, with a broad patch containing numerous fulvous bristles in front and a patch of white pubescence on sides, posteriorly with long white pubescence, this continued as a fringe on the trochanters and femora; femora testaceous, with dark patches apically, viewed from in front with a conspicuous patch of reddish pubescence beneath fringe at base; tibiae triangular in cross-section, outer face fuscous, cream-colored on apical fourth, the two inner faces pale testaceous; tarsal joints cream-colored, first joint strongly dilated, with a deeply hollowed-out scale above, which is fringed above with short dark bristles, the tip projecting beyond the base of the third joint; second joint not so strongly dilated, but narrowly produced forward beneath and beyond tip of scale of first joint, quite strongly dilated behind; third and fourth joints more regularly but less strongly dilated, all the joints with a strong white posterior fringe of pubescence which is strongly tipped with black beneath; middle and hind legs black; middle femora somewhat swollen, sparsely and finely punctured, middle tarsi slightly dilated, with long fuscous pubescence; pubescence of femora largely light; tibiae with short black pubescence in front, light behind; middle and hind tibial spurs dark fuscous.

Abdomen not fasciate, shining, punctures very fine, pubescence on first segment and on second except apical margin, pale, that on the remainder of the segments black; carina of sixth segment deeply and evenly emarginate, apical edge of segment with a triangular projection on either side of the middle; seventh segment conspicuously triangularly pointed. Length 11 mm.

This is close to *melanophoea* Sm., but in the latter the mandibles viewed from above are strongly angulate, the tarsal scale of the anterior legs is prolonged barely to the base of the third joint, the second joint is more widely dilated in front, and on the apex of the front tibia is a posteriorly projecting whitish scale, not present in *audax*. It is also close to *mucida* Cress., but the mandibles here also are strongly angulated, and the second and third tarsal joints are much more widely dilated than in either *audax* or *melanophoea*.

The type is in the collection of the State Department of Agriculture, Raleigh, N. C.

One specimen caught at Raleigh, May 8, 1922, on flowers of *Rubus*.

Megachile shermani n. sp.

Male: Face and clypeus densely pubescent, pubescence pale ochraceous; clypeus closely punctured (at least above); mandibles 4-dentate on apex, with a large inferior projection occupying the basal half, the apical end of which forms a small distally pointed tooth, and the basal end is produced to a large tooth, the apical teeth shining and impunctate, the outer surface with a few scattered punctures, finely pruinose, some long white pubescence below, upper surface finely, striately punctured, a small patch of white hair on outer edge about midway of base and apex; cheeks fairly broad below, narrower above, rugulose, with fine sparse punctures above, with white pubescence, dense below; vertex rather flat, punctures close medially, well separated laterally just above eyes, pubescence thin and light with a few dark hairs intermixed just above eyes.

Thorax finely and closely punctured, punctures well separated on scutellum and propodeum; pubescence white, mostly dark ochraceous on disk of mesonotum; tegulae red, closely and finely punctured, anterior border pale testaceous, with white pubescence; wings lightly infuscated more so apically, second recurrent nervure entering second submarginal cell slightly nearer apex than first does to base, basal nervure beyond transverse median; legs with light pubescence; front coxae dark, with white pubescence, and each with a large much flattened spine, rounded apically and with long white pubescence posteriorly; front trochanters and femora testaceous, fringed posteriorly with long white hair, femora impunctate except apical posterior portion which is finely and closely punctured, this area bounded below by the slightly produced edge of the joint and above by a sharp carina, the lower third being ivory-colored, the upper two thirds, brown; front tibiae three-sided, outer face piceous, yellow apically, punctate and pubescent, posterior face testaceous except for borders, anterior face testaceous medially, shading into brown above and below, both these faces smooth, shining and impunctate; tarsi yellow, widely dilated and strongly fringed behind, hairs of fringe being tipped with brown, metatarsus slightly hollowed out in front, next tarsal joint with a black spot beneath, which shows through on the upper surface; middle femora swollen, piceous or black; tibiae similarly colored except

for yellow apex, spur none, but a spur-like prolongation of the tibia present, this being somewhat shorter than the usual spur, rounded apically, pale yellow; tarsi yellow with black posterior border, somewhat dilated; hind legs piceous, tarsi yellow, with a posterior dark border, the metatarsus slightly dilated; claws yellow, tipped with piceous, cleft.

Abdomen rather short and broad, punctures mostly fine, close basally, the apical end of segment 5 with large and confluent punctures; dorsal segments 1–5 fasciate, the first on sides only, the fascia widely interrupted on 2, entire or but slightly interrupted on 3 and 4 (specimen somewhat rubbed), entire on 5, disks of segments 2–4 with short black pubescence; carina on terminal segment crenulate, deeply emarginate medially, the surface of the segment above the carina confluently punctured, with small scattered tubercles, the surface below somewhat similar, but more shining laterally, segment just before emargination of carina strongly "pinched in" above and below apical edge of segment with a low carina on either side of middle, and and laterad of these a small sharp spine; seventh segment hardly visible, truncate, apparently with a very minute point in the middle. Length 11 mm.

The type is in the collection of the State Department of Agriculture, Raleigh N. C.

One specimen caught at Beaufort, N. C., July, 1904, by Franklin Sherman.

Osmia albohirta n. sp.

Female: Blue, with greenish tints; pubescence white, with no intermixture of dark hairs. Head closely punctured, punctures fine below level of antennae, especially on inner orbits; clypeus slightly convex, very closely punctured, the punctures fine below, apical margin shining, black, slightly produced medially, entire; mandibles tridentate, hardly expanded at apex, the apex of the middle tooth about equidistant from the outer and inner teeth; malar space none; antennae black, flagellum obscurely reddish below.

Thorax with crowded, fine punctures; triangular area of propodeum with a narrow, finely rugose area above, this produced downward medially in a broad V, the apex of which reaches to about the center of the enclosed area which is elsewhere finely tessellated; propodeum elsewhere tessellated, rather coarsely so just below enclosed area; tegulae polished, piceous, greenish anteriorly, with scattered, fine

but distinct punctures; wings slightly infuscated, more so apically, nervures dark, basal nervure before transverse median; legs black without green reflections, with white pubescence, fulvous on tarsi beneath.

Abdomen finely and rather coarsely punctured, punctures on median segments coarser and more widely separated than on basal segment, apical segment with punctures very fine and close; scopa white, some times dark on the last segment. Length 10 mm.

This is an *Osmia* s. str., and of the eastern species of this group *O. inspergens* Lov. & Ckll. is the only other one having a white scopa with which it might be confused. The two species differ as follows:

O. inspergens—mandibles expanded at apex, the middle tooth nearer the outer one than the inner tooth, a bevelled cutting edge between the middle and inner teeth; mandibles when closed meeting at an angle of about 45 degrees; clypeus convex and produced beyond the suborbital line; thoracic punctures not crowded; apical spines of middle tibia shorter.

O. albohirta—mandibles hardly expanded at apex, the middle tooth about equidistant from outer and inner teeth, with no bevelled cutting edge; mandibles when closed subparallel with each other; clypeus but slightly convex, hardly produced beyond suborbital line; thoracic punctures crowded; apical pine of middle tibia longer.

This species seems to have a general distribution over the eastern part of the state, specimens having been caught at Raleigh, Aberdeen, Willard, Bolton, and Fairmont (W. B. Mabee), from April 15 to June 10, on flowers of *Rubus*, *Vaccinium* and *Penstemon*.

The type will be deposited in the National Museum.

DEPARTMENT OF AGRICULTURE,
RALEIGH, N. C.

THE WATER DOGS (NECTURUS) OF NORTH CAROLINA

By C. S. Brimley

Water dogs are salamanders of rather large size, which may be distinguished from all other tailed amphibians by the combination of persistent external gills with four-toed hind feet, the former character distinguishing them from the great majority of salamanders, while the latter separates them from all the forms with permanent gills.

There are only two species in the genus (and family) both of which are confined to North America and both of which occur in North Carolina. These two species are the common water dog (*Necturus maculosus*) which is spotted with black above, and often below also, and the Carolina water dog (*Necturus punctatus*) which is wholly without dark markings. The former species is much the larger, northern specimens reaching a length of 15 inches or over, while the average adult of *punctatus* is not apt to be over 6 inches long, the matter of size is however somewhat confused by the fact that the larger species is represented in North Carolina by a form which is not a great deal larger than the adults of the smaller one.

The smaller species (*N. punctatus*) is found only in the lower courses of the rivers of North and South Carolina, and until last autumn was known in this state only from the vicinity of Wilmington. However Mr. W. B. Mabee and I did considerable roadside collecting in November and December of last year (1923) and very materially added to its North Carolina range. The first we caught were during November when on our way to Willard, we stopped at Mingo Creek and did considerable dipping in the creek and its backwaters to see what we could find. Among other things we found ditch fishes, pygmy perch, and a number of apparently larval salamanders which we did not then recognize but which later proved to be the young of this species; on our way back we picked up one or two more in a small creek near Clinton. Later in the month we caught a number more in Buffalo Creek near Wendell (Wake county). All of the specimens so far taken were small, none being over $2\frac{1}{2}$ inches long and some not half that length. A later trip in December into Harnett county, gave us a few more small ones, and one adult (6 inches long) from Upper Little River, near Bunlevel, and a still later one to Little River, near Wendell, contributed four more adults and several young. The adults were

all found where bunches of dead leaves or other trash had caught in the water against the bank, while most of the young were caught by persistent dipping in rather deep water, but some, particularly the Mingo Creek specimens, were in shallow water. The animal is brown above, whitish beneath and the only markings are round whitish dots which are sparsely present on the body but more plentiful around the edges of the tail fin. The young look a great deal like the larvae of the red salamanders of the genus *Pseudotriton* and *Gyrinophilus* and it is rather curious that these in their late larval stages have practically the dentition of *Necturus* and according to Cope are identical in osteological characters except that they lack the intercalary bone between the exoccipital and the skull.

It may be noted here that the discovery of this species at Mingo Creek, Clinton, and Bunlevel materially increased our knowledge of its range in the Cape Fear drainage, but the finding of it in Little River, and in its tributary, Buffalo Creek, added an additional river system to its range, as it had never before been taken in any tributary of Neuse river.

The larger species (*Necturus maculosus*) has a much wider range, extending throughout the Great Lake region, northern New York State, the Mississippi Valley and the Atlantic Coast from Louisiana to North Carolina. Northern specimens attain an extreme length of at least 15 inches and weight of half a pound, while the North Carolina specimens seldom exceed $7\frac{1}{2}$ inches, and weigh less than two ounces when adult. That these small specimens are not merely young is indicated by the fact that no larger ones appear in my recorded list of over forty specimens from the vicinity of Raleigh, collected between 1894 and 1924. Also they all have the ground color of the underparts wholly pale, never at all darkened, as is often wholly or partially the case with the large northern form. Young specimens of the northern form are said to be striped with black, but the smallest of ours that I have seen (measuring only about $3\frac{1}{2}$ inches in length) was spotted exactly like larger specimens. In view of these facts it would seem fairly apparent that the dwarf form occurring at Raleigh is a geographical variant or subspecies of the true *maculosus*, and I propose for it the name *Necturus maculosus lewisi*, the subspecific name being given in honor of Mr. Frank Bartto Lewis from whom I received the greater part of my specimens. Type will be deposited in U. S. National Museum (No. 6868, C. S. Brimley, coll.; taken Feb. 25, 1921, in Neuse River, near Raleigh, by F. B. Lewis).

Most of the water dogs taken at Raleigh have been caught on hook and line in early spring, and those that I have data on were all caught in running, not still water. Mr. Mabee and I caught some half a dozen of this form while dipnetting in Neuse River near Raleigh during the past December and we noticed that while we caught them among trash, often in small backwaters, it was always where the main stream of the river was swift and not where it was sluggish.

Besides Raleigh, *maculosus* has also been taken at Kinston, Tarboro and Chapel Hill, but I have not seen specimens from any of these other localities.

STATE MUSEUM,
RALEIGH, N. C.

AMOEBOID BEHAVIOR OF THE LYMPH CELLS IN SEA-URCHINS

By H. V. Wilson

The fluid in the coelom and in the so-called "blood-vessels" of *Arbacia punctulata* includes five kinds of cells: (1) small transparent and colorless, delicate cells (leucocytes of Goodrich and Kindred), the central body of the cell about 8μ in diameter; (2) colorless amoeboid cells, typically elongated, about 25μ long; (3) red amoeboid cells very like the preceding; (4) ellipsoidal or simply rounded yellow cells, fewer in number than the others, about 8μ long; (5) spheroidal flagellate cells about 8μ in diameter.

The clotting, which has been described by Geddes, Cuenot and others is due primarily to the activities of the first of the above mentioned cells. These by pseudopodial union establish a reticular syncytium, including comparatively dense cell aggregates, which entangles the other elements. The syncytium may be produced as an incrustation over a cover glass or other body, or it may be induced to contract into a compact spheroidal mass, lymph ball, the general surface of which is smooth. Cover glass preparations and lymph balls may be kept alive in the sea water for several days (a week).

The pseudopodia of the lecuocytes are primitively membranous, the filose appearance being illusory (Goodrich 1919) or secondarily attained (Kindred 1921, 1924). Theel (1921) regards the two types of cells, those with membranous and those with filose pseudopods, as possibly distinct. Round the edge of the denser cell aggregates and lymph balls are formed not only filose pseudopods and networks of the same but pseudopodial expansions of other types, all ectosarcal in appearance, as follows: (a) delicate thin sheets which peripherally break up into a few filose pseudopods, (b) low, bleb-like protrusions varying to lobe-like formations as long as wide or longer, (c) very long, strong yet slender, pseudopods (rare), bent in peculiar fashion, reaching over 100μ in length.

In cover glass cultures, kept in sea water a day, compact slowly moving amoeboid masses, typical ones measuring 75 to 130 microns in length, may be found. These seem to be lymph balls small enough for the formation of a lobe-like pseudopod to induce locomotory, if very slow, motion.

Lymph balls fuse when brought in contact. The nature of the case excludes examination with a high objective, but the abundant presence of pseudopodial expansions at the surface of such balls makes it probable that the union is established through pseudopodial activity, as it is in the case of the individual lymphocytes which initiate the clotting.

The tendency of the lymphocytes to fuse with one another is so great that it overcomes whatever repellent specificity there may be in the cells of different species. This at any rate is true for the two urchins, *Arbacia punctulata* and *Toxopneustes variegatus*, the lymph balls of which readily fuse when brought in contact. In this matter the lymph cells of sea urchins behave differently from the dissociated cells of the sponge species which have been tested (H. V. Wilson, Galtsoff) for this point.

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A SIMPLE APPARATUS AND METHOD FOR THE INJECTION OF EARLY CHICK EMBRYOS

By W. R. Earle

Plate 31 and a Text Figure

While there has been some considerable reference in recent years to the methods of injecting the vascular system or other cavities of young embryos, the methods and apparatus used have not as yet found their way into the laboratories of many colleges. The method of injection to be described has an advantage in requiring no other apparatus than that found in the biological laboratories of most colleges, and in demanding no extraordinary skill in operation. It will be described as it was actually used in the injection of the vascular system of chick embryos of 28 to 80 hours incubation.

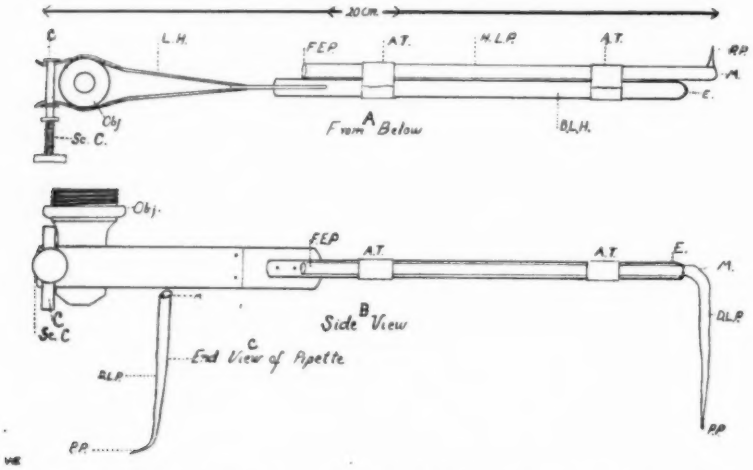
The central idea of the apparatus is to provide a minute pipette by which a colored fluid may be forced into the vascular, or any other system of cavities, of an embryo. This pipette is drawn from a piece of glass tubing about 4 mm. in diameter and 25 cm. long. Tubing having a thin wall is preferable.

Near one end, this tubing is drawn out in a Bunsen flame into a capillary of about 2 mm. diameter (Fig. 1). From this capillary the point of the pipette is drawn out. The best flame to use for doing this is a Bunsen, or better, a Tirril burner, with the barrel removed and the flame turned down to 4 to 6 mm. height. In this flame the capillary is slowly rotated until softened, when it is drawn out into a short, fine point.

The shaping of the point on the pipette is probably the most precise part of the whole injection process, but this can be done with a little practice. The shape desired may be seen in figure 1c. A longer, slender point, while more easily drawn out is so flexible as to be worthless. The desired shape is such as to give maximum rigidity, the cone shaped end sloping to a point fine enough to puncture the wall of the blood vessel or other cavity of the embryo. Such a pipette actually used for the blood vessels of a 30 hour chick had, by actual measurement, a diameter of 20 microns at the tip.

After getting the proper point on the pipette, the point is bent to slightly less than a right angle with the main tube (Fig. 1c). About

3 cm. above this bend the pipette is again bent, this time at a right angle, thus producing a short descending limb, which of course ends in the point, and a long horizontal limb (Fig. 1a, 1b). The long limb is then cut down to a length of about 12 cm., completing the pipette. To the free end of the long limb of the pipette, a rubber tube about 40 cm. long is attached, by which the observer may blow in the injecting fluid with his mouth.



Arm and pipette. A. T., adhesive tape; B. L. H., bar of lens holder; C., clamp (screw clamp as used on rubber tubing); D. L. P., descending limb of pipette; E., end of lens holder bar; F. E. P., free end of long limb of pipette; H. L. P., horizontal (long) limb of pipette; M., point of union between horizontal and descending limbs of pipette; Obj., objective of ordinary compound microscope; P. F., point of pipette; Sc. C., screw of screw clamp.

In using this pipette, especially when injecting the younger embryos, accurate movement is necessary. This is attained by making the injections under a binocular dissecting microscope, to the stage of which an ordinary detachable mechanical stage has been clamped.

To support the pipette a lens holder with a bar about 30 cm. long is used. Such a lens holder forms part of a well known type of simple dissecting microscope stand. The lens holder itself embraces the objective of an ordinary compound microscope and is held firmly attached to the objective by an ordinary screw clamp such as is used

on rubber tubing (Fig. 1a, 1b). The bar of the lens holder is of course horizontal and reaches out over the stage of the second microscope, the binocular previously referred to. The pipette is fastened to this bar by means of two stripes of adhesive tape passing around the bar and the long limb of the pipette.

In practice, the chick embryo is mounted *ventral side up* in a stender dish of warm normal saline, the dish being placed on the mechanical stage of the binocular. It will be readily seen that mounted in this way the embryo can be moved very accurately in either horizontal direction by means of the mechanical stage, while the vertical height of the pipette above the embryo can be controlled by means of the fine adjustment of the microscope supporting the pipette.

An easy method of mounting the chick in the stender dish is to have the bottom of the dish covered with a layer of gelatin, (25% gelatin, 75% water), the chick being pinned out to this solidified mass. The advantage of gelatin over wax will be seen later.

In the injection of chicks of about 30 hours it is easier to inject through the heart. In older chicks it is usually easier to inject through the anterior vitelline vein or, in some cases, the sinus terminalis. H. McL. Evans, as cited by Knower (1908), highly recommends that after the heart has begun beating the injection be made into the dorsal aorta, the fluid being thrown in toward the heart. I have not tried this though it would probably give excellent results.

Whatever be the site of injection, it is brought to the center of the binocular field by means of the mechanical stage. About 1 cc. or less of injecting fluid being drawn up into the pipette, the pipette tip is also brought into the binocular field, and by means of the adjustments of the mechanical stage and the fine adjustment of the microscope supporting the pipette, is inserted through the wall of the blood vessel. This done, the injecting fluid may be slowly blown into the vessel.

As an injecting fluid Higgins' waterproof india ink, in most cases diluted with from 1 to 4 volumes of normal saline, has been found excellent. In spite of the colloidal character of this ink, no trouble was experienced due to flocculation caused by such a dilution.

No extra precautions were found necessary for warming the injection fluid before injection. This was due to the fact that during the whole injection the tip of the pipette, containing the injecting fluid, is immersed in the warm saline in which the embryo is pinned out, and as the injection fluid is blown in so slowly and through such a small tube, the warmth of the surrounding saline is sufficient to warm the

injecting fluid to the correct temperature. I cannot say how this method would work for a gelatin injection mass.

Upon the completion of the injection, following the fixation and hardening of the chick in the usual way, any adhering ink may be cleaned off under the binocular, using a fine camel's hair brush. In some cases it may be advantageous to dissect off the amnion, due to ink getting into the amniotic cavity and obscuring detail. The chick may be mounted in balsam under a supported cover in the usual way.

A word may be said in reference to the lighting used on the chick during injection. The pipette is inserted by reflected light. However, to observe the progress of the ink through the capillary net transmitted light is almost obligatory. In practice it was found best to use two lights, one above the object, the other transmitting its rays up through the gelatin. By using one light or the other close observation may be kept on the whole process of injection.

In closing I would like to express my appreciation to Dr. H. V. Wilson, Professor of Zoology, University of North Carolina, for his valuable suggestions and criticisms in the preparation of this article.

UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, N. C.

BIBLIOGRAPHY

BROWN, A. L. 1922 A Simple Apparatus for Delicate Injections. Anatomical Record, XXIV, 295–297.

BUELL, C. E. JR. 1922 Origin of the pulmonary vessels of the chick. Contributions to Embryology, XIV, 11–26. Carnegie Institute, Washington. (Method of injection described.)

CHAMBERS, ROBERT. 1922 New apparatus and methods for dissection and injection of living cells. Anatomical Record, XXIV, 1–19.

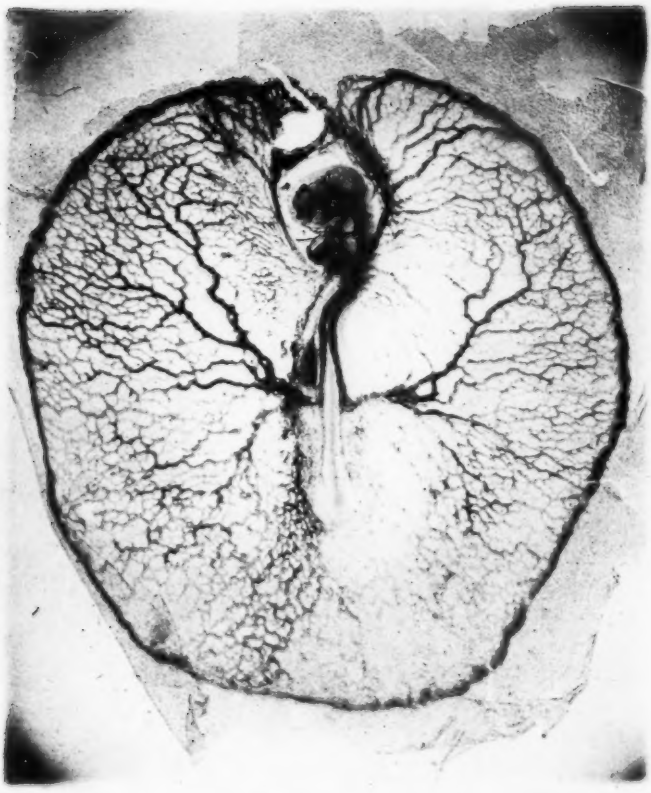
CUNNINGHAM, R. S. 1916 On the development of the lymphatics of the lung in the embryo pig. Contributions to Embryology, IV, 45–68. Carnegie Institute, Washington. (Methods of injection are described).

GREGORY, E. R. 1916 A Method of Micro-Injection. Anatomical Record, XI, 29–30.

KNOWER, H. McE. 1908 A New and Sensitive Method of Injecting the Vessels of Small Embryos, etc., under the Microscope. Anatomical Record, II, 207–214.

MALONE, R. H. 1918 A Simple Method for Isolating Micro-organisms. Journal of Pathology and Bacteriology, XXII, 222. (An arrangement of two microscopes, somewhat similar to that described above, is here used.)

PLATE 31



W. R. Earle fecit et photo.

INJECTED CHICK EMBRYO, AT END OF SECOND DAY. TWO ANTERIOR VITELLINE VEINS, TWO AORTIC ARCHES, TWO DORSAL AORTAE. PHOTOGRAPH. ×9

McCLENDON, J. F. 1907 Experiments on Eggs of Chaetopterus and Asterias. Biological Bulletin, XII, 141–145, Woods Hole, Mass. (Binocular microscope with mechanical stage, equipped with a special fine adjustment, is here used. To the latter a pipette is attached connected with a tube the end of which is held in the mouth of the operator.)

POPOFF, DEMETRIUS. 1894 Die Dottersack Gefässe des Huhnes, pps. 15–19. C. W. Kreidel's Verlag (abstract only consulted).

SABIN, F. R. 1915 On the fate of the posterior cardinal veins and their relation to the development of the vena cava and azygos in the embryo pig. Contributions to Embryology, III, 532. Carnegie Institute, Washington. (Methods of injection described.)

VARIATION OF PROTEIN CONTENT OF CORN

PAPER III

By H. B. ARBUCKLE and O. J. THIES, JR.

Synopsis of Paper 1: (*This Journal* **38**: *84, 1922*)

1. A rapid Kjeldahl method for the determination of nitrogen in corn, average time of digestion 35 minutes.
2. Report of analyses of certain varieties chosen for experiment.
3. Corn grown in North Carolina from West Virginia seed showed lower protein.

Synopsis of Paper II: (*This Journal* **39**: *56, 1923*)

1. Brief discussion of facts presented in paper I.
2. Errors arising from employing varying amounts of alkali in neutralizing Kjeldahls.
3. Reports of analyses of corn grown in North Carolina and West Virginia.
4. In two samples of corn grown in North Carolina the protein content shows marked increase.
5. Two varieties of corn grown in West Virginia from North Carolina seed show different results. One gave no marked change in protein. The other a decided increase.
6. Immature corns show low protein in every case.
7. Report of analyses of additional varieties.

INTRODUCTION

Former papers give a short method of nitrogen determination in cereals, developed by the authors, and present analyses of varieties of corn grown in North Carolina and West Virginia with a view to discovering the influence of climate upon the protein content. The data was not sufficient to justify definite conclusions.

During the summer of 1923, further investigation of influence of climate was undertaken and the influence of fertilizers was studied. This paper presents the results of these investigations:

TABLES GIVING RESULTS OF ANALYSES 1923

Silver King corn (white) grown in West Virginia in 1923 from seed grown in West Virginia in 1922. Protein content of seed 8.68 %.

	CC NO FERTILIZER	CC-1 COMPLETE FERTILIZER 8–2–2, 300 LBS.	CC-2 PHOSPHORIC ACID 16%, 300 LBS.	CC-3 SODIUM NITRATE 200 LBS.
	per cent	*per cent*	*per cent*	*per cent*
Nitrogen:				
No. 1	1.475	1.775	1.435	1.815
No. 2	1.452	1.761	1.408	1.795
Mean	1.464	1.768	1.422	1.805
Protein	9.15	11.04	8.88	11.28

Golden Dent corn (yellow) grown in West Virginia in 1923 from seed grown in West Virginia in 1922. Protein content of seed 8.22 %

	EE NO FERTILIZER	EE-1 COMPLETE FERTILIZER 8-2-2, 300 LBS.	EE-2 PHOSPHORIC ACID 16%, 300 LBS.	EE-3 SODIUM NITRATE 200 LBS.
	per cent	*per cent*	*per cent*	*per cent*
Nitrogen:				
No. 1	1.689	1.762	1.478	1.556
No. 2	1.644	1.761	1.507	1.584
No. 3	1.644	1.747		
Mean	1.659	1.757	1.493	1.57
Protein	10.36	10.98	9.33	9.82

White Plume corn (white) grown in West Virginia in 1923 from seed grown in West Virginia in 1922. Protein content of seed 8.37%

	BB NO FERTILIZER	BB-1 COMPLETE FERTILIZER 8-2-2, 300 LBS.	BB-2 PHOSPHORIC ACID 16%, 300 LBS.	BB-3 SODIUM NITRATE 200 LBS.
	per cent	*per cent*	*per cent*	*per cent*
Nitrogen:				
No. 1	1.467	1.525	1.462	1.481
No. 2	1.441	1.507	1.460	1.520
No. 3	1.431		1.455	
Mean	1.446	1.516	1.459	1.500
Protein	9.04	9.48	9.10	9.38

Blanchard White or Goodman Prolific (white) grown in West Virginia in 1923 from seed grown in North Carolina in 1922. Protein 9.36 %

	K NO FERTILIZER	K-3 SODIUM NITRATE 200 LBS.
	per cent	*per cent*
Nitrogen:		
No. 1	1.641	1.667
No. 2	1.618	1.707
No. 3		1.669
Mean	1.63	1.681
Protein	10.19	10.5

White Cap (yellow and white) grown in North Carolina in 1923 from seed grown in West Virginia in 1922. Protein of seed 9.84%

	GG-3 SODIUM NITRATE 200 LBS.
	per cent
Nitrogen:	
No. 1	1.694
No. 2	1.680
Mean	1.687
Protein	10.55

Analysis of Silver King (white) corn grown in North Carolina in 1923. Seed grown in North Carolina in 1922. Protein of seed 9.62%

	DD
	per cent
Nitrogen:	
No. 1	1.456
No. 2	1.484
No. 3	1.469
Mean	1.47
Protein	9.19

Analysis of grains from different parts of an ear chosen from White Cap corn.

	ANALYSIS OF GRAINS FROM BUTT	ANALYSIS OF GRAINS FROM MIDDLE	ANALYSIS OF GRAINS FROM TIP
	per cent	*per cent*	*per cent*
Nitrogen	1.402	1.46	1.486
Protein	8.76	9.46	9.29

This ear unfortunately proved to have a protein content much below the average of this sample.

The average of these three portions of the ear is 9.17% of protein, which is very close to the figure obtained for this ear, 9.07%.

COMMENTS ON ABOVE RESULTS

All samples grown in West Virginia in 1923 showed higher protein than the seed grown in West Viriginia in 1922.

Silver King 0.47%, White Plume 0.67%, Golden Dent 2.14%. The slight increase in the first and second might be explained by the more favorable conditions of 1923, or by better methods of drying. The marked increase in the third corn cannot be explained in this way.

The moving of Goodman's Prolific to West Virginia seems to have produced an increase of 0.83% which may be explained by the more favorable season in West Virginia, rather than by influence of climate.

The moving of White Cap from West Virginia to North Carolina seems to have produced an increase of 0.71% of protein, but this corn was grown with a heavy application of sodium nitrate, which may explain the increase.

The Silver King corn grown in North Carolina from seed grown in North Carolina shows a decrease of 0.43%, which may be explained by the long dry season of 1923.

The results of the three years' experiment with Golden Dent deserves special notice. The sample grown in North Carolina showed 6.82% of protein. The corn grown from this seed in West Virginia in 1922 showed 8.22%. The corn grown in 1923 in West Virginia from the 1922 seed showed 10.36%. This corn has rapidly advanced protein for some reason, and calls for further investigation.

In making the above comparisons the samples grown without application of fertilizers are chosen.

The authors have undertaken to show the influence of fertilizers on the nitrogen content. Three widely different corns, Silver King, White Plume, and Golden Dent, were each grown in four plots in West Virginia. Each variety was tested with no fertilizer, a complete fertilizer, phosphoric acid, and sodium nitrate. The above results would indicate that the complete fertilizer and sodium nitrate increased the nitrogen content, while phosphoric acid had little effect, with a tendency to a lower figure. In no case have we a marked change in spite of very liberal application of the fertilizers. It is quite evident that the increase of nitrogen would not be sufficient to pay for the fertilizer.

The White Cap corn moved to North Carolina from West Virginia was unfortunately grown only with fertilizer, through a misunderstanding of the farmer who was kind enough to test this corn for us. Next season this rich protein corn will be grown under the same conditions of fertilization as have been employed with the other corns.

We have further investigated the grains from different parts of the ear, and the results show that the grains of the middle portion are richer in nitrogen. This shows how difficult it is to get a fair sample of corn for analysis, and suggests that better results would follow the use of grains only from the middle portion of the ear.

Different ears from two of our samples were analyzed. The results are not reported because it calls for the analysis of corn taken from a larger number of ears. We learned, however, that there is a distinct variation in ears of the same corn, which suggests the taking of a larger number of ears than twelve to secure a fair average. This confirms the work of Gerber and Hayes that showed that increase of protein could be secured by selection of ears of high protein content.

It is probable that there is a marked variation in nitrogen content of different grains on the same ear. It is the purpose of the authors to attempt to determine nitrogen content of individual grains by Nesslerizing the distillates after Kjeldahl's digestion.

SUMMARY

1. Presentation of analyses to show the effect of fertilizers on protein content of corn.
2. Comments on results.
3. Discussion of variation of protein content in different ears, different parts of same ear, and different grains of each portion of the ear.

DAVIDSON COLLEGE,
DAVIDSON, N. C.

OPPORTUNITIES FOR CHEMICAL INDUSTRIES IN NORTH CAROLINA

By E. E. Randolph

In order to assure the largest measure of success in chemical manufacture a locality should possess the following conditions:

1. A sufficient transportation system.
2. A constant source of raw materials.
3. An economical source of power.
4. A pure water supply.
5. A supply of skilled and common labor.
6. A ready market for its manufactured products.
7. A climate suitable for all-year-round normal production.

It is interesting to note how North Carolina meets these conditions.

A Sufficient Transportation System

Traversing the state from north to south are three trunk railways, two of which are double-tracked. From east to west the state is crossed by three railroads and their connections. In addition to these main lines other lines contribute much to the transportation system. A complete network of 5,063 miles of railroads touches almost every county of the state. Over 3,500 miles of highways have been graded and surfaced, over 2,000 miles of which being hard-surfaced, and other road improvements are provided for so as to make the improved roadway total over 6,300 miles. These extensive railway and highway systems place every portion of the state in direct connection with every commercial center of the country and with every important seaport. In addition two of the most important seaports, and others of much importance, of the Atlantic coast are in immediate touch with our industries. Some of the rivers are navigable for a considerable distance.

Raw Materials

In raw materials the state produces the seed from over a million bales of cotton and crushes, but does not refine, them. It also produces $75,000,000 worth of tobacco, 130,000,000 pounds of peanuts, more soy beans than any other state, $59,000,000 worth of corn. The long catalogue of raw materials includes hides; livestock; milk pro-

ducts; tan bark; forest products for lumber, turpentine, naval stores, charcoal, acetone, industrial alcohol, and paper pulp (100 tons of which are being manufactured daily in the three paper mills of the state); rags and waste paper for finer grades of paper; tanned leather; crude oil for refining; a varied mineral output including gold, iron, tin, and copper in workable quantities; vast quantities of mica; feldspar and kaolin for china, porcelain, pottery, and enamel ware; talc for cosmetics, rubber filler, asphalt binder, roofing; limestone and silica for glass; gas plant products; fish scrap; raw material for the enormous amount of glue used in the annual production of $30,000,000 worth of furniture manufactured within the state.

Source of Power

The water power of the state is producing 360,000 horsepower, about one-fifth of the possible development. In the Deep River coal fields 235 tons of good coal are mined per day. The United States Geological Survey estimates that there are more than 67,000,000 tons of good coal in this region. The West Virginia and Tennessee coal fields are nearby, and our hydro-electric lines are linked in with the super-power system of the Southeast.

Skilled and Common Labor

In educational effort North Carolina is setting a splendid example to the world. The General Assembly has generously provided for the public school funds, its literary, professional, and technical colleges, so that men now have the opportunity to train themselves to take care of all the future industrial development of the state. Halifax county furnishes a good illustration of how the negro children are being provided with inviting school opportunities. Through the generosity of a benefactor any negro school community in the South can secure from $500 to $700 for a school building provided they themselves raise an equal amount. Then the county and state supply the remainder. This county has built within the past three years thirty such negro rural schools costing from $3,000 to $3,500 each, painted and neatly furnished. Such educational awakening in all classes of our population assure the skilled and common labor necessary for our industrial development. Also the fact that less than 5% of our population is foreign born is a strong safeguard against industrial discord.

A PURE WATER SUPPLY

Very little of North Carolina water is hard water and hence caking and scale in boilers rarely occur. The quality of water is of vital importance in many manufacturing processes. Only in special cases does the water need treatment, and even in such cases suitable locations can easily be found in the state; so that little purification of the water is needed even for exacting requirements. Some of the waters of the western part of the state do not even require filtering for the finest grade of work.

A READY MARKET

A market here at home would consume a large percentage of the chemical products produced in the state. The manufacturing, agricultural, and domestic needs of the state at present require large quantities of chemicals.

About one-sixth of the manufactured products of the state at present are chemical products. Nearly all other industries use large amounts of chemicals or employ chemical engineering principles. The three great American dye companies have southern headquarters in the state doing a business of approximately $20,000 daily.

The success of manufacturing pure chemicals in North Carolina has passed beyond the experimental stage. The output of 1922 demonstrates that it pays to utilize our raw materials, natural power, and favorable conditions to turn our materials into finished products here at home. The value of our ceramic products was $2,265,000; leather $10,434,000; ice, $1,956,000; cottonseed products over $46,000,000; fertilizers over $25,000,000; gas, $1,169,000; cheese, $28,200; turpentine and rosin, $160,000; fish scrap and oil, $718,500; butter, $492,000; sizing compounds, $15,000; electroplating, $10,000; asbestos products, $1,000,000; paints, $100,000; mercerized yarn, $591,000; soaps and shoe polishes, $75,000; tanning extracts, $650,000; salt brick, $12,000; paper pulp, $4,600,000; rubber goods, $2,250,000.

AN EQUABLE CLIMATE

Massachusetts finds it profitable to produce chemicals even though part of the year is unsuited to producing many chemical products on a paying basis, and in some cases a plant can run only a part of the year. North Carolina offers a climate which is suited to continuous production.

The Merrimac Chemical Company of Massachusetts affords a fine illustration of profitable production in even unfavorable surroundings and conditions. The plant produces daily 35 barrels of acetic acid, 40 tons of contact sulphuric acid, 28 tons of chamber sulphuric acid, 20 tons of bauxite alum, 18 tons iron free alum, 20 tons of hydrochloric acid, 29 tons of Glauber's salts, 2 tons of carbonizer, 17 tons of nitric acid, besides bisulphite, fertilizer, H-acid, phenol, benzol, and picric acid in varying quantities. None of the raw materials for this vast industry are produced in Massachusetts except the water. The plant is 20 miles from the seaport. The power is obtained from a steam plant. The practical reasons for such a plant in Massachusetts are that the soil is not adapted to extensive agriculture, thousands of people need employment, and capital finds it profitable to manufacture these raw materials notwithstanding the shipping costs of raw materials, the unfavorable climate several months of the year, no hydro-electric power, and the somewhat unfavorable location of the plant. It would seem that North Carolina would find it profitable to extend its chemical manufacturing in new fields, considering the fact that the state produces much raw material and has in some respects more favorable natural conditions for manufacturing.

SUMMARY

North Carolina is rich in natural resources in its agricultural products and forest products, in its minerals, in its fish and fish products, and in its water power. It has a splendid transportation system by sea and by land. Its climate is suitable for all the year around production. A program is being worked out to give the state over 6,000 miles of improved highway. A wonderful educational awakening is affecting the whole people. These facts foretell the coming of greater industrial activities in the state. The value of the chemical products ranks third on the list of the major products of the state. In this increased industrial activity more and more opportunities arise for students properly trained for the requirements of chemistry in industry.

STATE COLLEGE,
RALEIGH, N. C.

SOME OBSERVATIONS UPON THE REPRODUCTIVE RATE OF EUGLENA TRIPTERIS AND EUDORINA

By Bert Cunningham and Carrie Hearne

Plates 32–36

In the fall of 1920, when the senior author was preparing to run some physiological experiments on pure cultures of diatoms, he received from a former student an almost pure culture of *Euglena*. While the species of this genus was not determined with any accuracy, it was taken to be *Euglena viridis*. While waiting for the pure cultures of diatoms to grow, some experiments were performed upon the practically pure culture of *Euglena*. The results obtained were striking, and so contrary to the general concept in the mind of the experimentor, that he determined at some later time to repeat the experiments and to obtain further observations. This opportunity first presented itself during the past year when the junior author entered a course at Trinity College. The general plan of the experiments herein reported and the interpretation of the data were made by the senior author. The routine of carrying out the experiments, counting the cultures, and general supervision of the experiments were in the hands of the junior author.

In most of the text discussions of *Euglena* we find that *Euglena* are reported as being synthetic organisms. This idea had been challenged in our minds for some time, due to the fact that the more transparent forms of *Euglena* and forms like *Peranema*, which are closely related to *Euglena*, are found in water comparatively poor in organic substance, while the green and red forms of *Euglena* were more often found in the stagnant water of old pig pens. In order to determine the synthetic power of these organisms it seemed comparatively easy to control the entrance of the carbon dioxide to the cultures and thus limit photosynthesis. For that reason, we prepared two trains of bottles similar to our diagram arranged in the following manner:

An air pump was attached to the Y tube at *a* and a control of the pressure in the two trains was secured by clamp valves at *b* and *c*. These clamp valves were regulated to admit approximately the same number of bubbles per second to each culture bottle. Bottles D and J

were used simply as air reservoirs. Bottle E contained a concentrated solution of sodium hydroxide. Bottle F contained a solution of barium hydroxide, while bottles G, K, L, and M contained only water. Bottles I and O also contained water and acted as traps. Bottles H and N contained the cultures. When air was pumped through this train of bottles, that reaching the culture bottle H was practically devoid of carbon dioxide. That reaching N would be simply moist air, having passed through three bottles of water.

The materials used in these experiments were *Euglena tripteris*, which were found in almost pure cultures, and *Eudorina*, also in nearly pure cultures, furnished us by Mr. A. F. Roller of the Raleigh High School.

In order to secure a basis for determination of the effects of air without carbon dioxide and natural air containing the normal amount of carbon dioxide upon a culture, the bacteriological method of aliquoting was resorted to. The approximately pure cultures of *Euglena tripteris* were thoroughly shaken in filtered pond water which had been taken from the pool where the *Euglena* occurred. Aliquot parts of this mixture were poured into equal quantities of water in each of the culture bottles. Air was then pumped through slowly for a few minutes each day. Definite quantities, i.e. 1 cc. of water, were removed from these cultures each day, diluted to 10 cc. with 4% formaldehyde, and then 1 cc. of this material was counted. Three samples were taken in each case and the average of these three samples was used as a basis for the figures of our tables. This experiment was carried on for a period of from eighteen days to nearly two months, with individual cultures.

A little later nearly pure cultures of *Eudorina* were available and a similar set of experiments were carried out upon them.

The results obtained from these experiments have been graphed in this paper, but may be summed up briefly as follows:

Eudorina in the laboratory continues to reproduce when natural air is pumped through the culture flasks for a period of approximately fifteen days, then the culture decreases. When the carbon dioxide has been removed from the air there is a steady decrease in the number of *Eudorina* from the beginning. But in the case of *Euglena tripteris* the opposite is to be observed. In the cultures in which the carbon dioxide has been removed from the air the *Euglena* become more abundant for a period of several days. In one case this abundance persisted until the 19th day, then rapidly decreased. Only in one case

did the line cross that representing *Euglena* in natural air. In the case of natural air there was a gradual decrease in the number of individuals. Having found by this method that the reproductive rate of *Euglena* is more rapid without carbon dioxide than with it, we attempted to determine the relation of light to the reproductive rate of *Euglena*. We have also graphed these results in this paper. Experiments were run with air free of carbon dioxide, one experiment being in the light and the other in the dark. This experiment was repeated with natural air and the two graphs are shown herewith. Apparently light has little, if any, effect upon the number of organisms occurring under these conditions, since the curves are similar when the experiment is run in the dark and in the light.

One expects to find in these lower forms, containing chlorophyll, some relation between the anabolic rate and the reproductive rate. If, therefore, the *Euglena* were dependent upon synthetizing its own food one would naturally expect a greater reproductive rate in the cultures containing carbon dioxide, since this would imply greater food production. But this is not the case, so we must either believe that *Euglena tripteris* is capable of sustaining life without photosynthesis or that there is no relation between the anabolic rate and the reproductive rate in these lower forms. The former assumption seems to be the more logical, viz. that this *Euglena* is capable of living without anabolizing its own food. A further assumption must be made in the case of *E. tripteris*, and that is that in some way the presence of carbon dioxide inhibits the reproductive rate. Just how this inhibition works, we are not able to say. On the other hand, in the case of *Eudorina* there does seem to be a relationship between the anabolic rate, which is presumably controlled by the carbon dioxide, and the reproductive rate, for the reproduction rate falls rather rapidly with the decrease of carbon dioxide.

Further studies related to the phototrophisms of these organisms show that *Eudorina* are positively phototrophic, while *Euglena tripteris* is, under room conditions, negatively phototrophic. That is to say, on a slide they will retreat to the side away from the window.

Since these experiments bear out the results of the preliminary experiment mentioned above, and since more recent observations show *Euglena viridis* to be positively phototrophic, we doubt our original classification of the *Euglena* in the preliminary experiment. Furthermore, we would expect to find that *Phacus pleuronectes* would give results similar to those observed in *Euglena tripteris*, since this organism is negatively phototrophic.

While the evidence in these cases seems to be rather conclusive there are several possibilities which should not be overlooked. In the first place, the cultures of *Euglena* were not absolutely pure cultures, although actual observation would show but one or two foreign organisms to a couple of hundred *Euglena*. Such small quantities seem to be negligible as they could not possibly produce a sufficient amount of carbon dioxide to make any difference in the metabolic rate of *Euglena*. In the second place, the occurrence of the carbon dioxide in a solution may change the pH concentration in such a way as to inhibit the stimulus to reproduction. pH concentrations were run on some of the cultures, but sufficient data was not secured upon which to base any conclusions.

The fact that *Euglena tripteris* acts differently from *Eudorina* under these conditions is an indication of the difficulty of differentiating between "green" organisms which carry on "animal functions" and those which carry on "plant functions," and therefore the difficulty of differentiating plants and animals. On a basis of phototrophism we should expect *Euglena viridis* to resemble *Eudorina;* this would produce a schism in the genus *Euglena*. It is such data as this that justifies the division, *Protista*.

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EXPLANATION OF GRAPHS

Graph 1. Dotted line A average of *Euglena tripteris* for air free of carbon dioxide. Solid line B average of *Euglena tripteris* for natural air.

Graph 2. Dotted line A average of *Euglena tripteris* for air free of carbon dioxide. Solid line B average of *Euglena tripteris* for natural air.

Graph 3. Dotted line D average of *Euglena tripteris* for air freed of carbon dioxide. Solid line C average of *Euglena tripteris* for natural air.

Graph 4. Dotted line A average of *Euglena tripteris* in the dark natural air. Solid line B average of *Euglena tripteris* in the light, natural air.

Graph 5. Dotted line D average of *Euglena tripteris* in the dark. Air freed of carbon dioxide. Solid line C average of *Euglena tripteris* in the light. Air freed of carbon dioxide.

Graph 6. Dotted line C *Eudorina* culture average for air freed of carbon dioxide. Solid line D *Eudorina* average for natural air.

Graph 7. Dotted line A *Eudorina* average for air freed of carbon dioxide. Solid line B natural air.

Graph 8. Dotted line A *Eudorina* average for cultures in the dark. Solid line B *Eudorina* average for cultures in the light.

PLATE 32

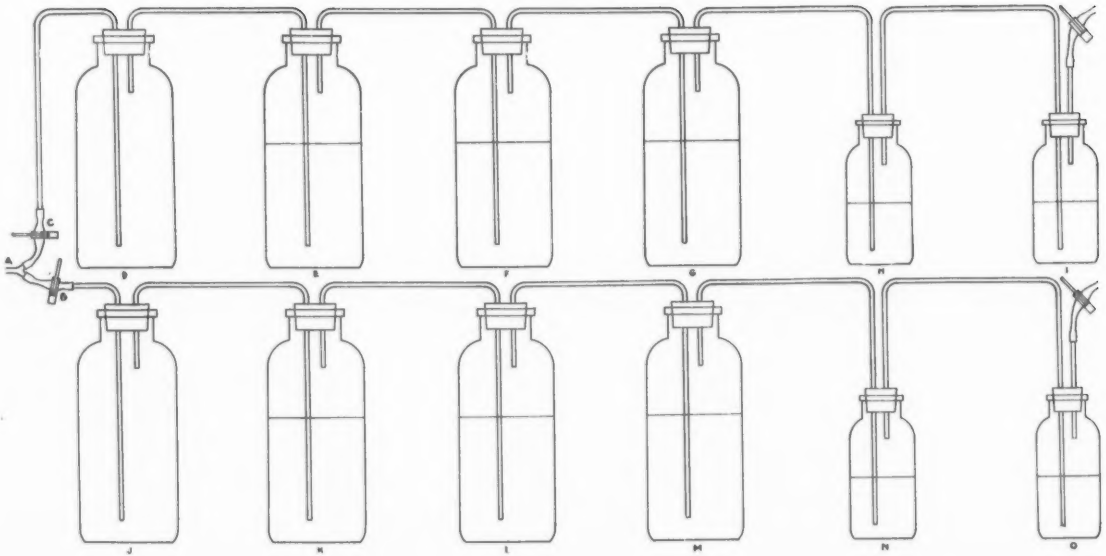
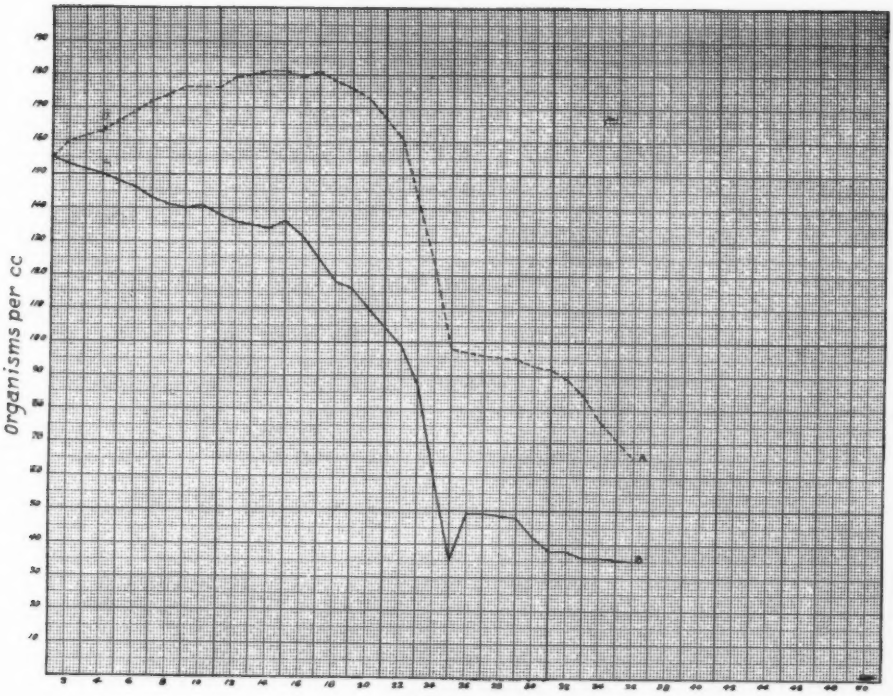
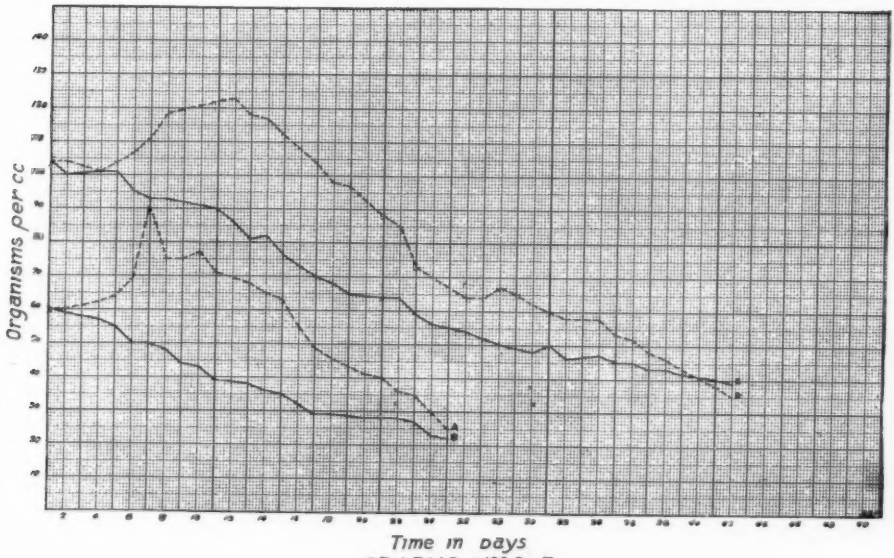


PLATE 33

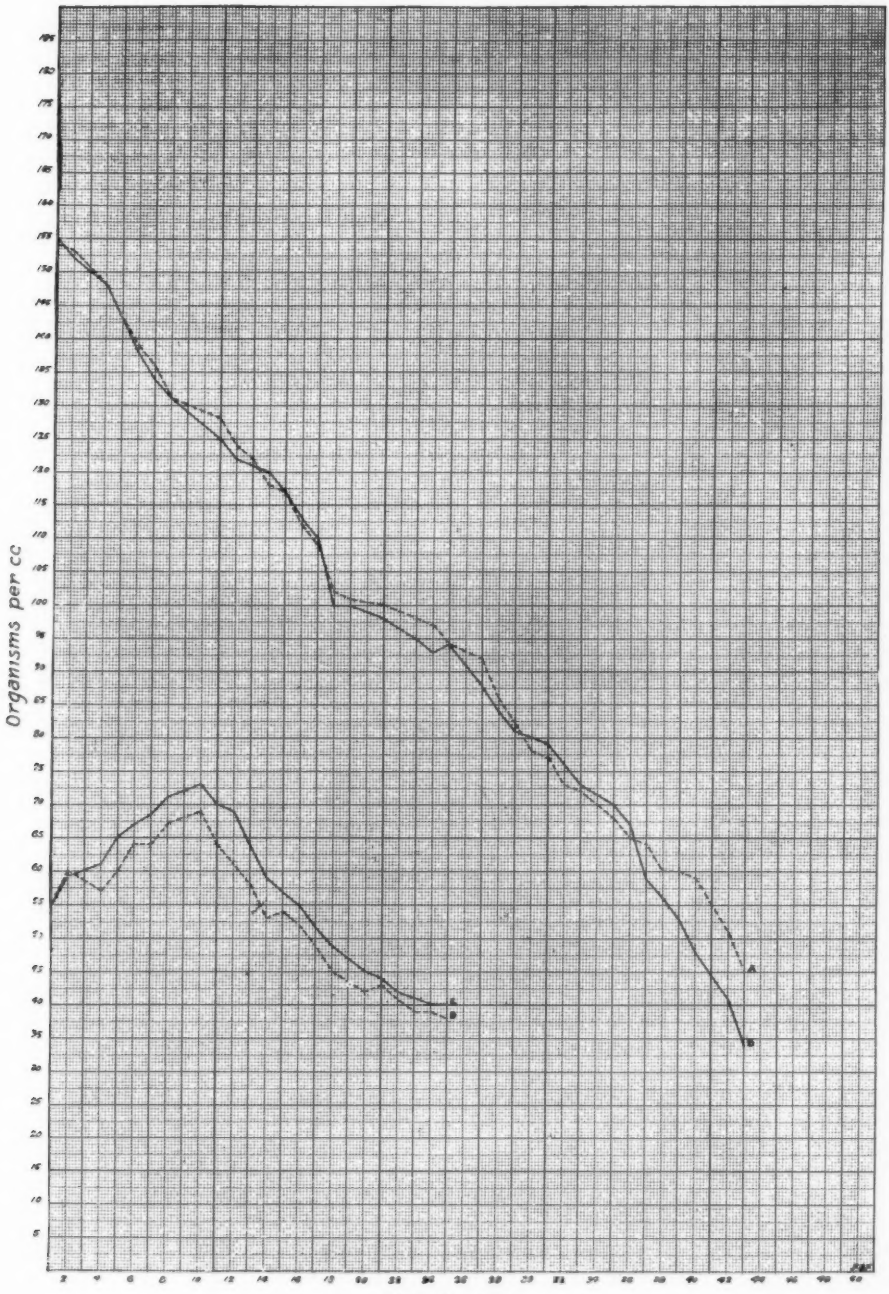


GRAPH Nº1



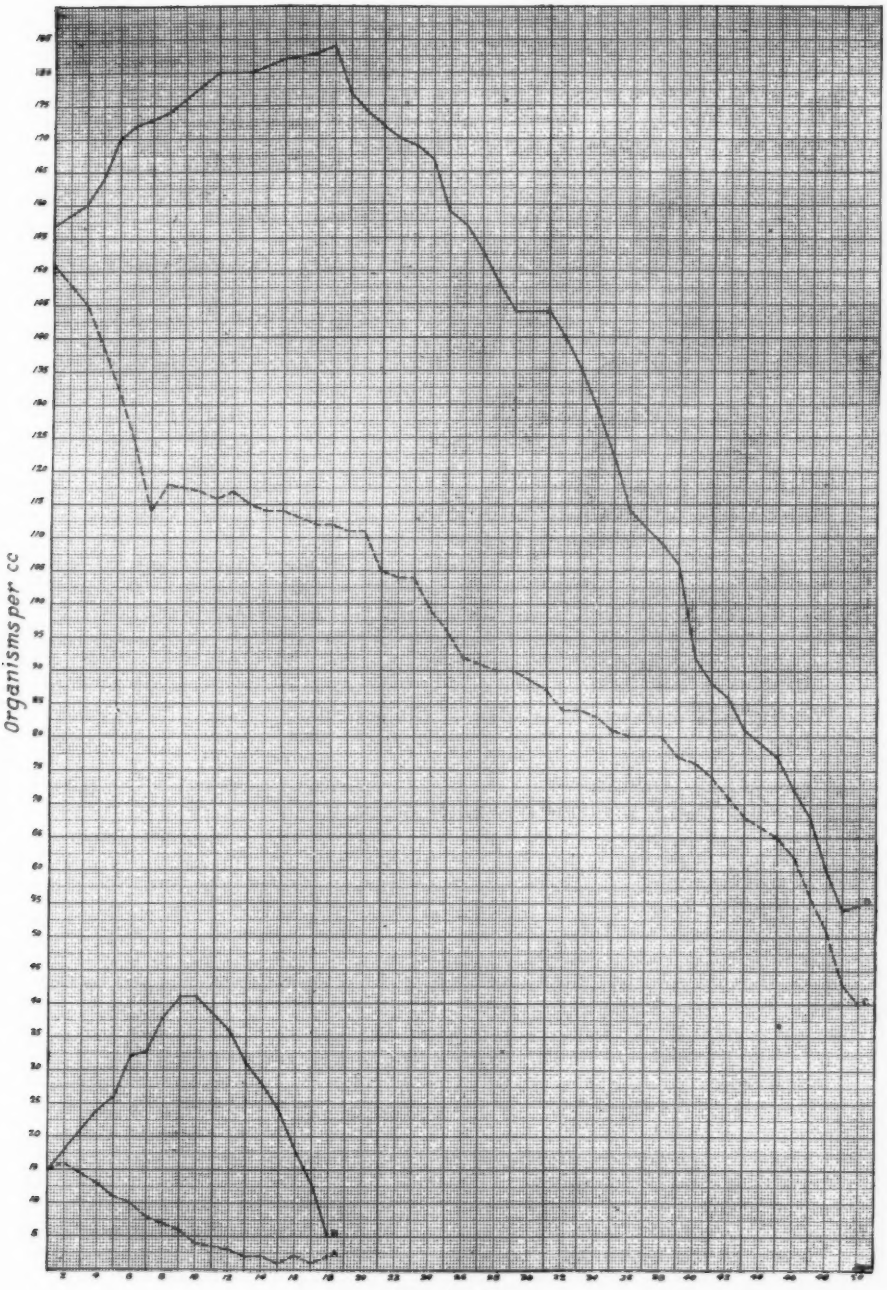
GRAPHS Nºs 2&3

PLATE 34



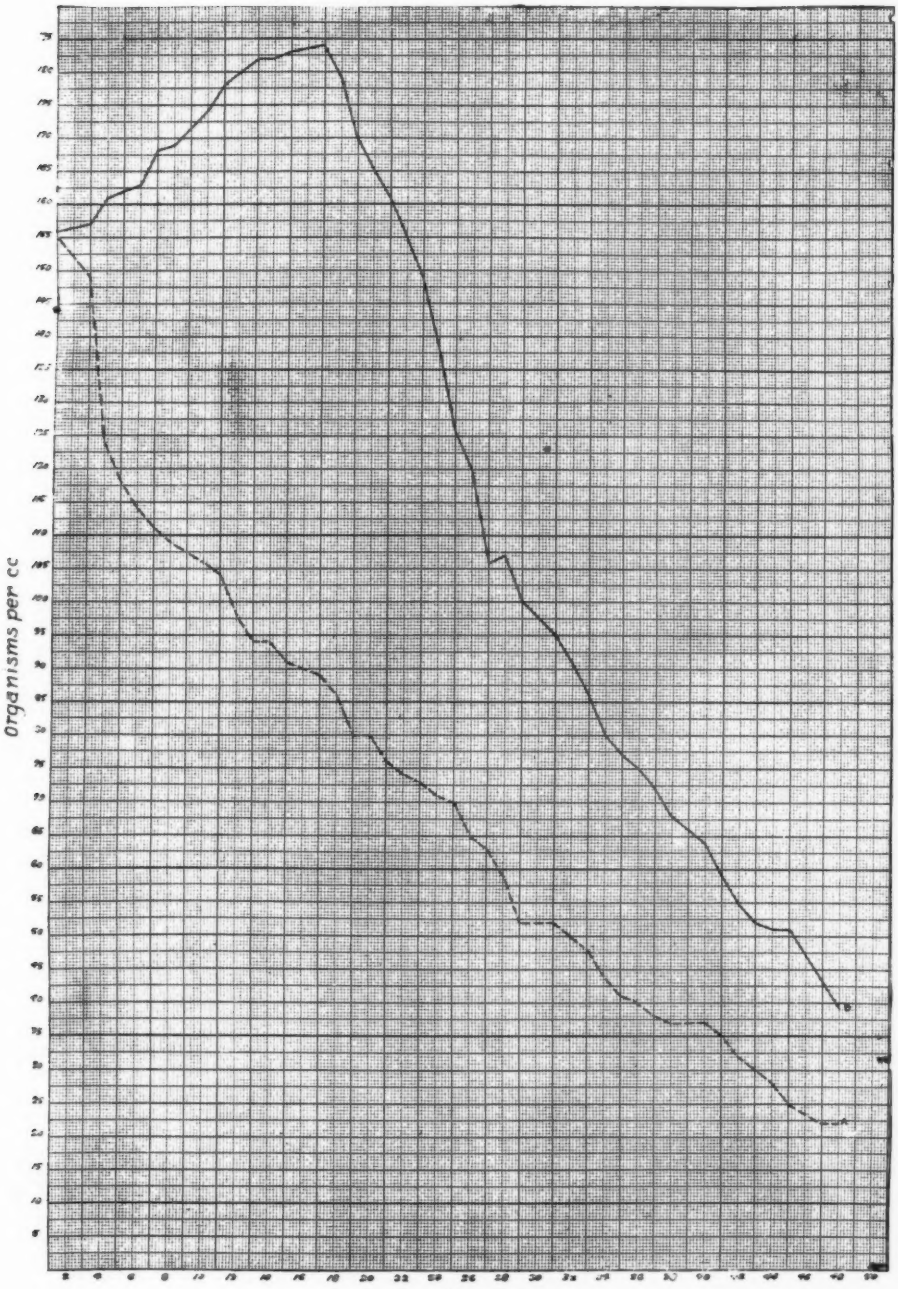
GRAPHS Nos 4&5

PLATE 35



GRAPHS Nos 6&7

PLATE 36



GRAPH Nº 8

"KEEPING UP" WITH LANTERN SLIDES

By Bert Cunningham

It seems quite probable to the writer that the use of lantern slides in teaching is much hampered by the difficulty of finding the right slide at the right time at a moment's notice. That slides are a valuable asset in teaching is almost a truism; rapid reviews of various related organisms can be pictured with precision and speed by their use, thus covering in a few minutes the same field that would require an hour of chalk talking. That a number of devices have been arranged for "keeping up" with the slides is evident, but most of them are either expensive or cumbersome. Some are both.

As our stock of slides increased, we were forced to find some way of keeping up with them. They were first divided into Botany and Zoölogy slides. But we were always wanting slides we were unable to locate except by looking through the file until we found them. A card catalogue scheme was devised but when two slides of a very similar nature were made, it was difficult to determine which was desired without recourse to the slides themselves.

We finally decided that a scrap-book of pictures of slides would help. All old negatives, from which most of our lantern slides had been made, were resurrected and prints made of them. When we found slides for which we had no negative, we proceeded either (1) to print a positive from the lantern slide if it were a table or chart. This of course must be printed through the glass, and therefore will not be absolutely clearcut; or (2) we would throw the picture on the screen and make a new negative and print from this; or (3) we would print a negative from the lantern slide and then a positive from this. In this case the lantern slide must be separated from its cover, and then later rebound. We therefore used the second method, as it was most convenient. The expense is very small in any of these processes.

The finished prints were then assembled more or less topically—Botany, Zoölogy, Embryology, Heredity, etc. Under each of these they were again assembled topically—under Zoölogy, for example, there will be found morphology, in which the slides are arranged according to Phyla; and physiology, according to systems. These pictures were pasted in loose leaf books. At present we have four such books. These are kept in a rack near the lantern slides, and one can find almost instantly the desired slide. Each slide is numbered and

the corresponding number is placed below the picture. If there are duplicate slides, both numbers are placed below the picture. Sometimes it is desirable to have pictures under two headings, e.g. typical cells—under both Botany and Zoölogy. If only one slide is available a picture of it may be placed in both books.

The slides are kept in boxes made up of units to provide for 500 slides. The actual wall space occupied by such a unit being 16 x 32 inches, with about five inches extension from the wall. The dimensions are shown in the accompanying sketch (Fig. 1). Each compartment contains 25 lantern slides, each transverse row 100 lantern slides. Since the slides are placed in numerical order it is no trouble to find any slide in a moment. Furthermore, you know exactly what the slide is going to show.

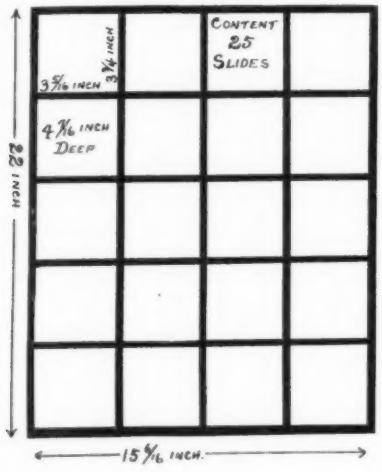


Fig. 1.

While getting the prints of the slides made earlier is tedious, once one has caught up, it is no problem to keep up, as prints are made from the negatives as rapidly as are the slides. The negatives receive the same number as the slide and are filed numerically, so broken slides may be easily replaced. This is not given as a totally new method, although the writer has never seen it or heard of it being used elsewhere; and the thought that this practice might be productive of the greater use of lantern slides has prompted him to publish it.

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THE LOESS DEPOSITS OF CHINA

With Special Reference to the Hwang Ho Valley

By Collier Cobb

PLATE 37

Loess is a finely comminuted sand or pulverulent loam of a yellowish to brown color, which occurs as a pleisticene alluvial or aeolian deposit chiefly in the valleys of the Rhine, the Danube, the Missouri-Mississippi and in the lowland of some other rivers, but especialy in that of the Hoang Ho, or Yellow River of China; and it extends from the lowlands to the mountain tops, becoming finer in texture as the greater heights are reached. In fact, a belt of loess-like deposits extends entirely around the earth in the northern hemisphere. The upper part of this deposit in Russia, for a score of feet or more, is colored black by a thorough admixture of organic matter. This apparently represents the accumulation of fine dust among rapidly growing plants, the decay of which furnished the organic matter present, which often amounts to as much as ten percent. It is also found in detached areas in other parts of the world, as is seen in the *regur*, or black cotton soil of the Deccan, in India. Yellow loess and a related black earth have been observed by the writer at several points in South America.

Loess, everywhere, consists chiefly of extremely fine clay, with some carbonate of lime and a little oxide of iron, mingled with fine quartzose and micaceous sand, and fresh or but little changed particles of feldspar, hornblende, and other rock-forming silicates. The quartz grains of the loess are remarkably angular; and the mica flakes, instead of being deposited horizontally, as they would be by water, lie scattered through the mass in every possible position and with no definite order. The materials of the loess are by no means of uniform size, even in the case of a single mineral; some being as fine as rock flour and others as coarse as fine sand even in the same handful, and sometimes exhibiting, in places, the character of gravel. In the loess are also found peculiar little concretionary masses which have become known as loess dolls, these apparently having been formed at a later period than the loess by the concentrating work of ground-water. The student of soils would class a loessal soil as silt.

In China the deposit reaches depths of 1,500 to 2,000 feet, and it frequently covers mountain slopes at heights ranging up to 8,000 or even 11,500 feet, often developed on one side of a mountain range and not on the other; and it sometimes appears on one side of a river though absent from the other, becoming very thin along the edge of the deposit.

This loess of China exhibits a very high degree of fertility; and, although its surface has been cultivated for thousands of years without the application of artificial fertilizers, it is still productive, owing perhaps largely to the constant addition of new material. Its extent appears to coincide with the limits of the most successful of Chinese agriculture, loess being the basis of the prosperity of northern China, where the climate is too dry to leach out the plant food from these finely comminuted soils.

These soils constitute the famous wheat lands of northern China, and it is here that we may see the wheat planted in rows and cultivated with a hoe. In the best wheat soils of this district the proportion of sand is greater than in the rest of the loess. This rule does not hold in the American wheat lands, where the finer-textured soils produce the best wheat. Wheat is the staple food of the better class of the Chinese in the north, as rice is in the south; and rice does not grow much north of the 32nd parallel of latitude, except in Kiangsu, and there are now upwards of 40 flour mills in the Yangtze valley. Imported rice constitutes an important part of the food of the wealthier classes in the north, while the masses of mankind live largely on millet.

In Kiangsu, too, cotton is an important crop. The food-stuffs grown on the loess of northern China are practically the same as those known throughout the same zone all over the world, except that the loess-grown product is of finer quality.

Loess has the property of maintaining a vertical face whenever a section is cut, due oftentimes, though by no means always, to the presence in it of minute vertical tubes which are more or less filled with mineral matter. This causes a vertical scaling off of matertial on the hillsides, producing a terracing effect with bluffs sometimes as high as 500 feet. Many of the roads have been worn deep into it by constant travel; the pulverulent material, loosened and broken up into dust by the passage of cart wheels or of wheelbarrows or by the pressure of feet, has been removed by the winds, until the roads have come to lie in canyon-like depressions, with vertical walls often of considerable height.

Throughout this district there are thousands of villages excavated in the most systematic manner at the base of cliffs of loess. These are dug, if possible, so as to get a south exposure. Doors and windows pierced through the natural front give light and air to suites of rooms, which are separated by natural walls and plastered with a cement made from the lime-loess concretions. Oftentimes these openings are framed with lumber brought down from the mountains farther inland, or, in rare instances, imported from America; and doors, sash, and even sometimes blinds, manufactured in Tacoma or Seattle, are imported by the most prosperous inhabitants. These are the comfortable dwellings of some hundreds of thousands of Chinese farmers.

In Shensi and Shansi the openings one sees in the bluffs along the road give access to small square caves or homes dug into the soft soil in which the roads are sunk. The dwellings have no windows and no means of ventilation. In many cases there is no way for the smoke to escape except through the door. The houses are warm and dry, but not otherwise comfortable according to our ideas, reminding one of the crude dug-outs of Nebraska. Above the houses, on top of the plain, are smooth fields where crops are growing, watered sometimes by streams and canals which have to be kept from the deep roads.

In crossing this loess plain district on the railway from Tientsin to Pukow the traveler finds it hard to rid himself of the impression that he is traveling in an uninhabited or sparsely-settled country; and he as frequently finds himself wondering where laborers may be had in sufficient number to cultivate so well such vast areas. The only people he will see are the few who congregate around the railway stations; but when a train runs over a bridge across a deep ravine, or crosses a river, he has but to look down to get a good view of some of China's teeming millions.

This is even more noticeable on the Peking-Hankow railway, as well as along the Pien-Lo railway which it crosses at Chengchou. This Pien-Lo railway connects the two old capitals of Kaifeng-fu in the east and Honan-fu in the west; and, at the time of my visit in 1920, trains were running through to Suchow, a considerable city on the Tientsin-Pukow line. For almost the entire distance from Kaifeng to Suchow the railway follows the old (now dry) bed of the Yellow River, and the station stops afford one an excellent opportunity to examine the loess bluffs on its right bank.

Incidentally, many of the streams in this district show a distinct right-hand deflection, the left bank of the river having a very slight

slope and often being swampy, reminding one of Fishing Creek, Tar River, Neuse River, or almost any of the streams of our Atlantic coastal plain in North Carolina. The approach to the stream on the left is over lowland or swampy ground, while the roadway on the right is on solid ground to or from the river's brink.

Above Kaifeng there are two great dikes on the left side each 72 feet high, running parallel, and from 2,700 to 3,500 feet from the natural bank of the river, and the intermediate space is cut up into rectangular sections by transverse mounds. The more exposed districts are thus divided into a number of independent tracts arresting the overflow, and enabling the people to raise their crops in comparative security. The city of Kaifeng is three miles south of the Yellow River on the right bank, near the spot where the river often makes a dangerous breach, submerging a whole district. As a protection against the flood, rather than against human enemies, the city is surrounded by strong walls of embankments, which however, are not always strong enough to protect the inhabitants from the ravages of angry waters.

At Kaifeng begin the changes in the river's course that have caused the Hwang Ho to be known as "China's Sorrow." At the present time the river flows northeast to its outlet in the Gulf of Chihli, a course it has followed since 1854. Before that date, for half a millenium, it made its way southeast through Hsuchowfu and the succession of lakes which led it to the sea in the neighborhood of Haichow, but slightly to the south of the bay of that name.

Between these two main channels of the Hwang Ho, the old bed and the new, lies the mountain and promontory part of the province of Shantung, China's "Holy Land," whose inhabitants now include its territory in the provinces of the Hwang Ho basin.

Yet the ancient discharge of the river in the province of Kiangsu indicates that the basins of the Hwang Ho and the Yangtz Kiang in their eastern and lowest sections are not easily defined, and this conclusion is confirmed by an examination of the Hwei drainage area, which reveals a large number of streams flowing parallel to the older beds of the Hwang Ho, but discharging into the Hwai Ho, which itself empties its waters into the Hungtze Hu, which in turn passes on its surplus in no small measure to the Yangtze, but also to the Yellow Sea.

Along the Ku-lu Ho and its continuation in the Sha Ho, through whose channels the waters of the Yellow River have sometimes reached the Yangtze, the high bluffs are all on the right, and the cave dwellings of the Chinese are in evidence for many miles; while the opposite, or

left bank, has everywhere lowlands and swamps reaching from the river's brink one or two, and even, in one case, to a distance of three miles. This deflective effect of the earth's rotation has been observed all over the earth wherever the superficial deposits present the favoring condition of horizontal homogeneity.

The many changes in the streams of the loessal plain of China that have taken place within historic time; and still others about to take place, with results whose disastrous character may be readily predicted, constitute the sad story of "China's Sorrow," due in large measure to deforestation with no thought of conservation.

The origin of loess, especially of that of China, has been for many years a matter of controversy—at times more or less acrimonious—among geographers and geologists. The first extensive study of the subject was made by Baron von Richthofen, whose conclusions are known to all interested, and approved by most students familiar with the areas that he studied. Thomas Kingsmill was the first geologist to oppose Richthofen's explanation. He was followed, at a much later date, by Kingdom Ward, another critic of Richthofen's theories.

Still later, Bailey Willis studied the region in more detail, and described that extensive deposit of yellow earth hitherto called the Chinese Loess, applying to it the term Huang-t'u, the name of the village of Huang-t'u-chai, thus giving a local geographic name to a locally developed formation.

Willis translates Richthofen's definition as follows:

> The loess of China is, like that of the Rhine, an earth of brown color, so soft that one can easily rub it to pieces with the fingers, and yet at the same time so firm that in places where through erosion, as by running water, large masses are broken off, it remains standing in perfectly vertical walls several hundred feet high. . . . It is so fine an earth that one can rub most of it into the pores of the skin; nothing then remains but some fine grains of sand, of which there are sometimes more, sometimes less. It is one of the most characteristic marks of the loess that these are angular, not rounded. By repeated washing with water, one can separate this from a much greater mass of material that may be called clay and is tinted brownish-yellow by iron. A third important element is carbonate of lime, which one may distinguish with the naked eye and which can be shown to be presented by the use of acid.

Willis then, adhering to Richthofen's definition of "loess," defines the Huang-t'u formation as

> That deposit of loess, sand, and gravel, which is wide-spread in the valleys of Chi-li, Shan-si, and Shen-si, which occurs to some extent on the adjacent mountains, and which forms the Great Plain of eastern China. It is characterized by

the predominance of loess as a chief constituent, and by the vertical cleavage peculiar to that variety of clay deposit. It sometimes is and sometimes is not stratified. It contains notable quantities of the saline substances taken up by ground water; contains nodules of carbonate of lime, which frequently occur at definite levels and are set with the longer axis vertical; and includes land shells and occasional bones, as reported by von Richthofen.

It is not my purpose to take part, at this time, in such discussions. In a later paper I shall proceed to consider these and kindred deposits as they occur over extensive areas of the earth's surface.

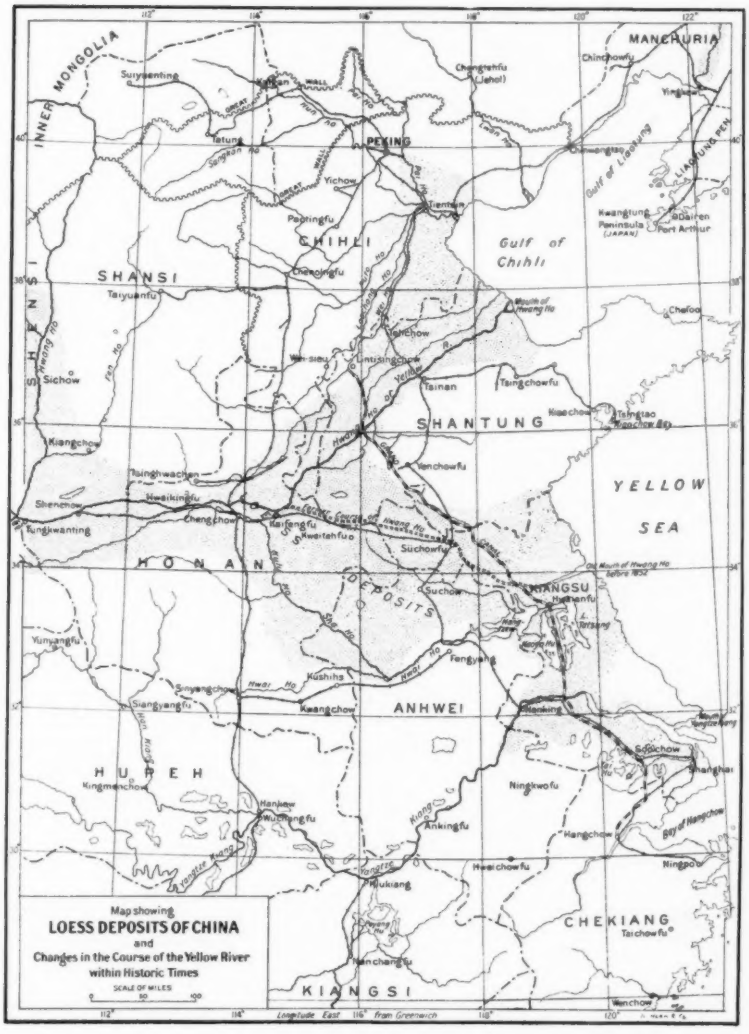
Distributive phenomena always have great value for the naturalist and, in the study of loessal deposits, they are not second in importance to structural features, or to the composition and texture of the material of the several terranes; while all of these, as well as the contained fossils must be taken into consideration in working out the geological history and mode of formation of these vast accumulations of fine dust-like terrestrial detritus. As our study of such varied and sundry phenomena proceeds, we shall most likely arrive at the conclusion that loess is due to a multiplicity of causes, that it is *polygenetic* in origin.

It is interesting to note that in many places the Chinese loess deposits weather into pinnacles or columns resembling those one may see in frozen snow, in icebergs, sometimes in glaciers, and especially in igneous rock masses. There are in all of these deposits fine fissures or close joints, such as traverse all rocks, but which are best seen in non-stratified masses. This columnar structure then, whether in the snow or in the loess, must be due to some secondary cause or "metamorphic" action, and not to anything taking place during deposition. We thus have an explanation of the scaling off of material and the formation of nearly vertical bluffs in the loess—an effect whose probable cause has given rise to much acrimonious discussion.

The purpose of this paper, then, has been to picture and describe the loess in some of its relations to mankind, to point out some hitherto unrecorded features of the stream deflection and development, and to suggest an explanation of the structure leading to loess bluffs and loess needles and loess erosion columns.

UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, N. C.

PLATE 37


MANCHURIA
INNER MONGOLIA
PEKING
CHIHLI
SHANSI
SHANTUNG
HONAN
ANHWEI
HUPEH
KIANGSU
CHEKIANG
KIANGSI
Gulf of Chihli
YELLOW SEA
Gulf of Liaotung
LIAOTUNG PEN
Kwangtung Peninsula (JAPAN)
Dairen
Port Arthur
Chengtehfu
Chinchowfu
Yingkow
Suiyuenting
Kalgan
GREAT WALL
Tatung
Yichow
Paotingfu
Tientsin
Taiyuanfu
Chefoo
Sichow
Lintsingchow
Yellow R.
Tainan
Taingchowfu
Kiaochow
Tsingtao
Kiangchow
Yenchowfu
Tsinghwachen
Hwaikingfu
Shenchow
Kungkwanting
Chengchow
Kaifengfu
Kwaitehfu
Suchowfu
Suchow
Hwaiyuen
Yungo
Yunyangfu
Fengyang
Kushihs
Siangyangchow
Siangyangfu
Kwangchow
Nanking
Soochow
Shanghai
Kingmenchow
Hankow
Wuchangfu
Ankingfu
Ningkwofu
Hangchow
Bay of Hangchow
Hwaichowfu
Ningpo
Hukiang
Kiukiang
Yenchangfu
Tarchowfu
Wenchow
Map showing
LOESS DEPOSITS OF CHINA
and
Changes in the Course of the Yellow River
within Historic Times
SCALE OF MILES
0 50 100
Longitude East from Greenwich

REVISION OF THE GENUS THRAUSTOTHECA, WITH A DESCRIPTION OF A NEW SPECIES

By W. C. Coker and J. N. Couch

Plates 38–40

In order to make a place for *Thraustotheca achlyoides* it was necessary to modify the definition of the genus to a slight extent (Journ. E. M. Sci. Soc. **39:** 112. 1923). The new species herewith proposed makes a still further modification necessary, but such modification seems to us to be more reasonable at present than the further increase of genera. The first sporangia to appear in the new species are of the *Achlya* type, but their successors are strictly of the *Thraustotheca* type and outnumber them greatly. Moreover, the walls of the *Achlya*-like sporangia are not like those of *Achlya* but of *Thraustotheca*, as they are delicate and ephemeral, disappearing in large part within a day or two after emptying. The sporangia of the *Achlya* type may be considered as the "youth form" and pointing to *Achlya* as the ancestor of *Thraustotheca*. It will be remembered that in several species of *Achlya* sporangia resembling those of *Dictyuchus* are at times abundant, and to a less extent those of the *Aplanes* type also occur. We would redefine *Thraustotheca* as follows:

Primary threads in greater part stout, branching; sporangia clavate to subcylindrical, often irregular, proliferating from below as in *Achlya;* spores always, or in the great majority, encysting within the sporangia when formed and later, in more or less angular form, swelling and escaping by the irregular rupture or disintegration of the sporangial wall; not escaping at once by an apical papilla except in the *Achlya*-like primary sporangia of one species. Oogonia with one to several eggs; antheridia present.

Three species are at present known, with *Achlya dubia* intermediate between this genus and *Achlya*. Sporangia of *Thraustotheca clavata*, *T. achlyoides* and *Achlya dubia* are shown on plate 38 for comparison with present species.

The genus *Thraustotheca* as at present constituted can be separated from *Achlya*, its nearest relative, by the fact that in the genus here revised the spores always or nearly always encyst within the sporangia

when formed, then later swell and are set free in a more or less angular shape not through an apical papilla but by the more extensive rupture or disintegration of the sporangial wall.

KEY TO THE SPECIES

Sporangia clavate, dehiscing laterally or apically, spores escaping only by the irregular rupture and disintegration of the sporangial wall..... *T. clavata*

Sporangia long-cylindrical, dehiscing by the breaking away of the apical part; sporangial wall not disintegrating..... *T. achlyoides*

First sporangia shaped as in *Achlya* and spores escaping as in that genus; the later sporangia (by far the greater number) long-clavate to cylindrical and discharging by irregular rupture and disintegration of the sporangial wall ..... *T. primoachlya*

Thraustotheca primoachlya n. sp.

PLATES 39 & 40

Growth fairly dense on mushroom grubs, termites, and bits of boiled corn grain; hyphae 10–100μ thick near the base in the same culture, considerably branched, tips pointed and hyaline when growing. Sporangia produced in great abundance: the first ones borne on the ends of the main hyphae and usually of the *Achlya* type, subcylindrical, rather stout and regular to slender and irregular, the wall thin and delicate, and soon (in a day or two) disappearing in part or entirely after emptying; the spores discharging through an inconspicuous apical papilla and clustering at the tip, connected by threads as in *Achlya* while emerging; later sporangia borne singly or in large clusters (up to ten or more) on the ends of hyphae, irregular in form, usually bent-cylindrical, rarely short-clavate as in *T. clavata*, thickest at the distal end, more or less rounded at the tip, quite often forked; renewed by cymose branching, their walls bursting at the tip or sides, or in both places, the spores swelling out by degrees and the sporangial wall in large part disappearing. Spores from the *Achlya* type of sporangia round when encysted, those from the *Thraustotheca* type angular; emerging and swimming with lateral cilia or sprouting in position. Gemmae not observed. Oogonia spherical to oval, borne on racemose branches, the length of which is from one to several times the diameter of the oogonia, 30–75μ thick, wall set with a few to a good many large, conspicuous, blunt projections 3–11μ high, and closed at the end by a very thin membrane. Eggs 16–23μ thick, one to sixteen in the oogonium, usually 4–8μ, eccentric, with a single, large, lateral oil drop; germinating after about three weeks into small sporangia which usually grow out through the oogonial papillae. Antheridial branches androgynous, usually arising from the same stalk that bears the oogonia, often branched; antheridia small, inconspicuous, finger-like and laterally applied to the oogonia; soon entirely disappearing, as if dissolved away.

Appeared once in considerably over a hundred collections made around Madison, Wisconsin, during the summer of 1923 and then in a small pond about five miles south of Madison. J. A. Lounsbury and J. N. Couch, coll.

This is indeed a peculiar plant. The remarkable regularity in the appearance and succession of two kinds of sporangia has no parallel in water molds. The numerous dictyosporangia often found in *Achlya hypogyna* and *Protoachlya paradoxa* do not show such synchronism in their appearance, although they are apt to be more abundant in old cultures. Another unique character is the extremely thin membrane which closes the ends of the oogonial papillae or cylinders which with ordinary magnification seem to be open. The regularity of the sprouting of the eggs is also unmatched in any water mold we have studied, though other authors have stated that the eggs of certain species sprout after a given time.

The behavior of the eggs in sprouting is the same as in *T. clavata* as described by Weston (Ann. Bot. **32**: 155. 1918) and the relationship to *T. clavata* us further emphasized by the conspicuous multiguttulate stage the eggs pass through before the uniguttulate condition of complete ripeness. At room temperature the eggs sprout in from ten days to two weeks after the culture is made. The changes in the sprouting egg are briefly as follows: The egg becomes larger; the oil drop is reduced to about one quarter its former size; the contents become more granular and much darker, and the wall becomes thinner. The contents may divide directly into spores or much more often a short germ tube is formed which grows through one of the papillae and cuts off a small sporangium outside, or not rarely the entire tube and egg space becomes the sporangium. Six to eight spores are usually formed and these may escape either after the manner of *Thraustotheca* or *Achlya*.

The alternation of the two kinds of sporangia, the *Achlya* with the *Thraustotheca*, is, of course, not a rigid rule, nor would one expect rigidity here or anywhere in the water molds. Notes on a few typical cultures will illustrate the usual procedure with variations: Eight cultures on pieces of boiled pop corn grains, examined when 16 hours old, all showed a good many sporangia, all of which, except a very few, were emptying as in *Achlya;* three days later all the cultures contained very many sporangia of the *Thraustotheca* type and very few of the *Achlya* type. Eight cultures on mushroom grubs formed sporangia sparingly in four cases and in fair numbers in four. All or nearly

all of these sporangia were of the *Thraustotheca* type. In numerous cultures on corn grain or hemp seed the very first sporangia were regularly of the *Achlya* type, a few of the *Thraustotheca* type soon appearing among them and a day later much surpassing the former in numbers. After a week such cultures show *Thraustotheca* sporangia in vast numbers and none to a very few of the *Achlya* type. Very small sporangia are not at all rare. These may terminate slender hyphal branches and contain as few as six spores in a row. One of the most remarkable peculiarities of the species is the large number of spores that sprout directly into small sporangia which are borne on the tips of slender germ tubes. These minute sporangia contain one to three or four smaller spores. (Fig. 13.)

When the fungus is grown on solid media such as corn meal agar a distinct diurnal periodicity in the formation of the sporangia is observable, the sporangia being formed in concentric rings which show up plainly to the naked eye as whiter zones with much wider, more hyaline zones between them. These concentric rings, one of which is formed every twenty-four hours, are very distinct at first and remain so until the fungus has covered the entire dish, then, due to the formation of later sporangia in the areas between the rings, they lose to a certain extent their distinctness. When normal day and night alternation of light is allowed, the sporangial development takes place in the afternoon and first half of the night, the vegetative growth continuing uninterruptedly until the entire dish is covered by the fungus. At room temperature this usually takes about a week and about five or six zones of sporangia are formed.

If on the other hand the fungus is kept growing in the darkness, no zonation occurs and sporangia are very slow to appear. A culture made on corn meal agar on February 17th, and kept in darkness showed no sporangia on February 23rd, a very few on March 5th and a good many March 17th, scattered over the entire culture; no zonation and no oogonia. The above experiment has been repeated several times with similar results.

The same tests have been made with *T. clavata* and *Achlya orion* with similar results, though in neither case was the zonation nearly so plain as in *T. primoachlya*.

This distinct diurnal periodicity in the formation of sporangia offers a parallel case to the daily appearance of a circle of oogonia in a new species of *Aphanomyces* which we find in Chapel Hill, and is of particular interest as it complements the work of Smith (Ann. Bot. **37:**

63, figs. 1–12. 1923) on *Saprolegnia diclina*, in which he found that by far the greater part of the nuclei divided during the latter part of the night to form spores on the following day.

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EXPLANATION OF PLATES

PLATE 38

Figs. 1–3. Sporangial dehiscence in *T. clavata*. x 700.
Figs. 4–8. Sporangial dehiscence and spore discharge in *T. achlyoides*. Figs. 4, 5 x 108; figs. 6–8 x 167.
Figs. 9–11. Sporangial dehiscence and spore discharge in *Achlya dubia*. x 167.

PLATE 39

Figs. 1–4. Tips of hyphae showing branched and gnarled condition characteristic of cultures on hemp seed in water. x 97.
Fig. 5. *Thraustotheca* type of sporangium. x 150.
Fig. 6. *Achlya* type of sporangium. x 150.
Fig. 7. Habit sketch of sporangia. x 89.
Fig. 8. Base of sporangium. x 402.
Fig. 9. Characteristic cluster of sporangia. x 97.
Fig. 10. Spores in *Achlya* type of sporangium killed while emerging and held by connecting threads. x 810.
Fig. 11. *Achlya* and *Thraustotheca* types of sporangia on same thread. x 54.
Fig. 12. Basal part of a nearly empty *Thraustotheca* sporangium showing clearly the angularity of the spores. x 402.
Fig. 13. Spores germinating within a sporangium and forming minute sporangia containing 2 or 3 spores. x 402.

PLATE 40

Fig. 1. Habit sketch of sporangia and oogonia. x 97.
Fig. 2. Oogonium with androgynous antheridium. x 402.
Fig. 3. Oognium with diclinous antheridium and ripening eggs. x 402.
Fig. 4. Oogonium with single ripe egg. x 648.
Figs. 5–9. Various stages in the germinating eggs. Fig. 5 x 648, others x 402.

PLATE 38

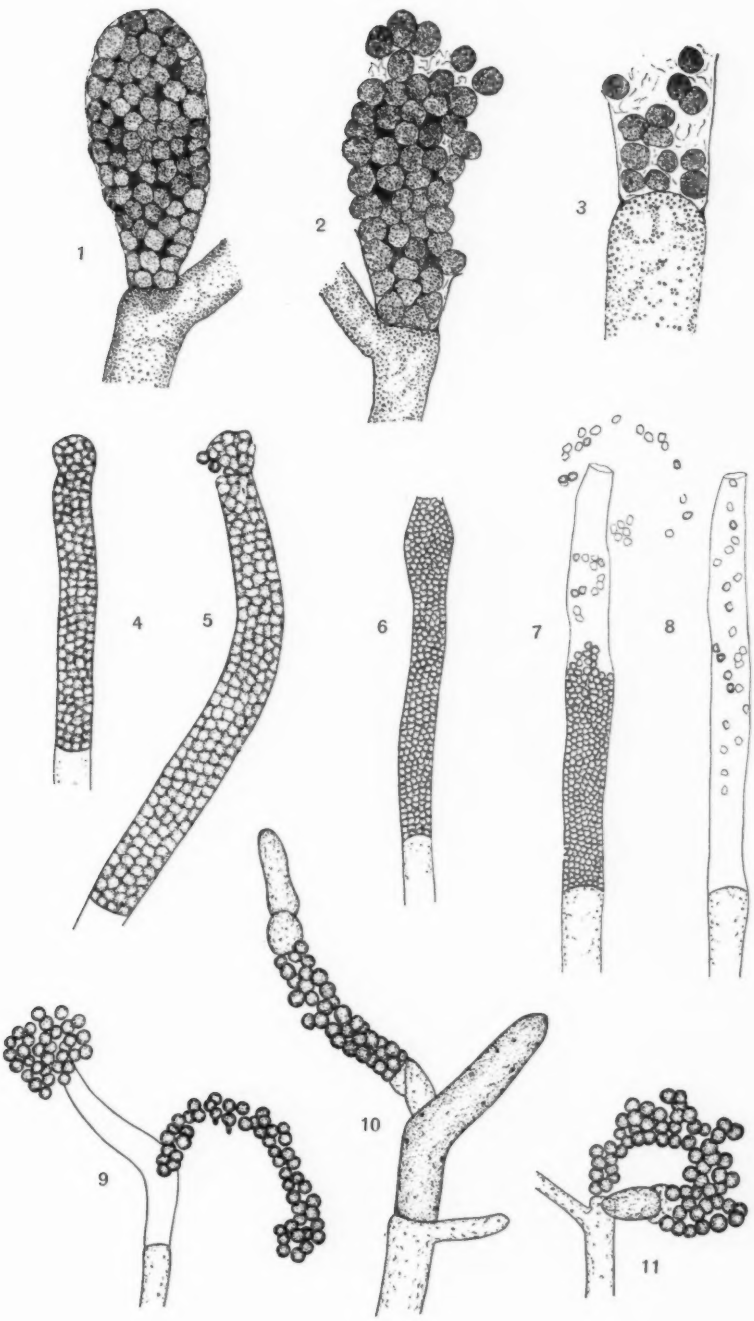


PLATE 39

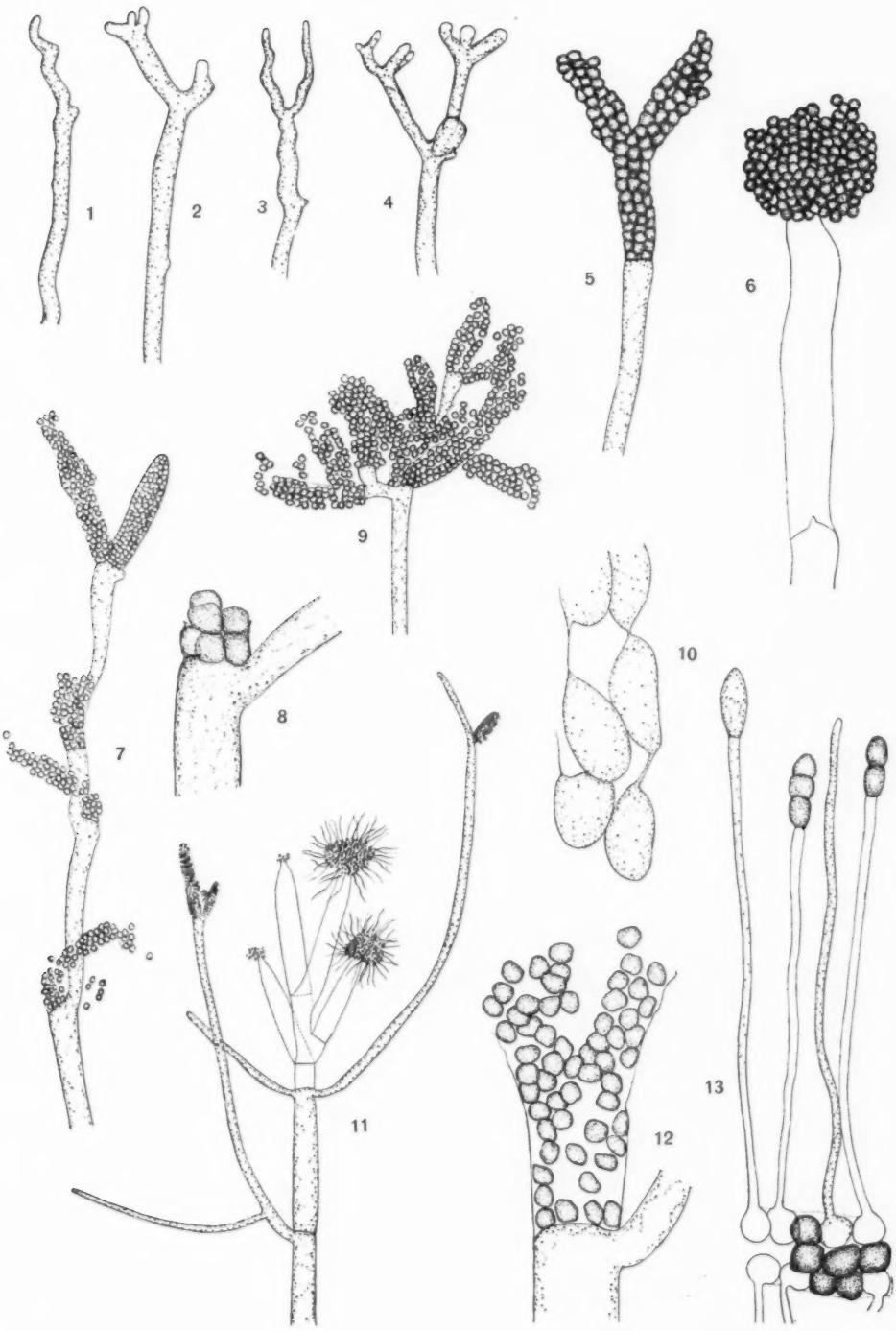
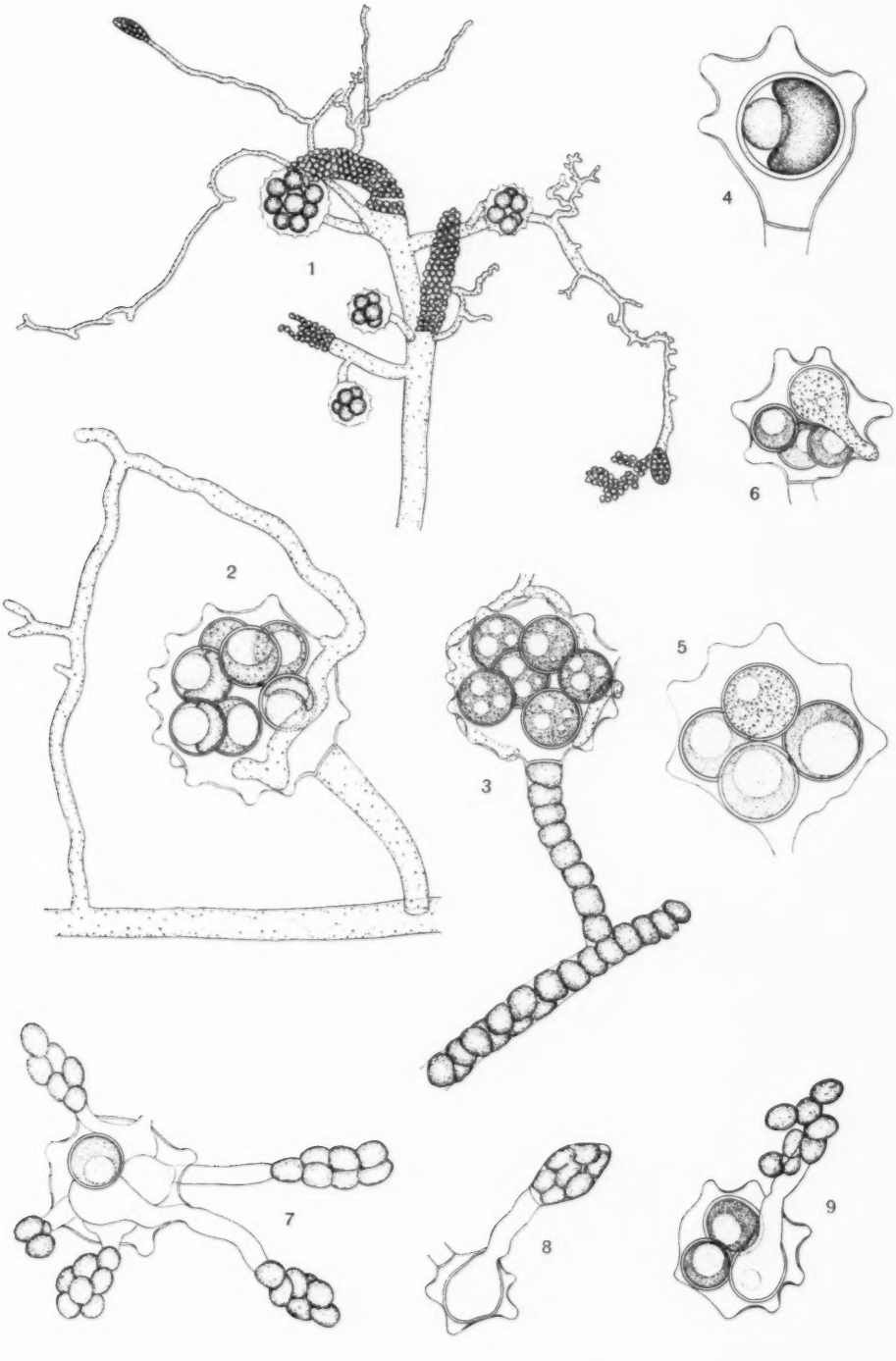


PLATE 40



A BIBLIOGRAPHY OF FISHES

A Review

A Bibliography of Fishes, Volume I, by Bashford Dean—Revised and extended by Charles R. Eastman, 718 pages; Volume II, (as above), 702 pages; Volume III, by Bashford Dean—Extended and edited by Eugene Willis Gudger with the coöperation of Authur Wilbur Henn, 707 pages. Published by the American Museum of Natural History, New York, 1916 (Vol. I), 1917 (Vol. II), and 1923 (Vol. III).

Some years ago, Prof. Bashford Dean, Curator of Fishes of the American Museum of Natural History in New York, began the preparation of a bibliography of fishes. Titles of publications relating either wholly or in part to fishes were listed alphabetically by authors in the first two volumes, published with the collaboration of Dr. C. R. Eastman in 1916 and 1917, respectively. Some idea of the magnitude and thoroughness of the bibliographers' task may be gained from the fact that the two volumes comprise 1420 pages, double column, ordinary print, of titles dating from the publication of the tenth edition of the *Systema Naturae* of Linnaeus in 1758 to the most recent times. There remained the great tasks of extending the bibliography to include all published references to fishes prior to 1758, and of preparing a subject index which should be the key to the whole work. At this stage Prof. Dean enlisted the coöperation of Prof. E. W. Gudger, well known to members of the North Carolina Academy of Sciences, not only as a native North Carolinian and for long Professor of Biology in the North Carolina College for Women, but also Secretary and Treasurer of the Academy from 1907 to 1918.

The third volume is much more than a subject index. It includes, first, a continuation of the list of Anonymous Titles. Then there are 135 pages containing the titles of Pre-Linnaean publications from the earliest record in 1758. There follows a list of General Bibliographies which include references to fishes another of Voyages and Expeditions relating to fishes, and one of periodicals relating to fish and fish-culture. A few pages are given to errata and corrigenda of Volumes I and II. Finally, there is the main part of the book—"The Subject Index." This comprises 347 pages and is divided into three sections which may be best described by their subtitles: "Morphological and General

Section, arranged under 118 specific and technical headings;" "Systematic Section, including Natural History and Occurrence and Taxonomy of Various Groups of Fishes and of Certain Specific Fishes;" and "Finding Index, Alphabetizing All the Materials in the Morphological and Systematic Sections of the Subject Index."

It detracts nothing from the scientific appraisal of the Bibliography as a handbook of modern science to say that one dips into the long list of Pre-Linnaean titles and the editor's explanatory notes upon them with rare fascination. We seem to follow the early history of natural science, as we pass from the 2 fishes of Homer, about 1000 years before Christ, to the 17 of Hippocrates, about 400 B.C., and the 53 of Ovid at the beginning of the Christian Era. We find a reference to what are perhaps the earliest extant directions for fish-culture, given by Marcus P. Cato about two centuries before the Christian Era. We pass over the familiar names of Hippocrates, Herodotus, Xenocrates, and Aristotle. We note the writers of the early Christian years: among them—Galen, Athenaeus, (who writes, about 200 A.D., of such modern topics as fossil fishes, sounds made by fishes, restoration of fishes after freezing, migration, and amphibious fishes), Saint Ambrose, Ansonius (on fishes of the Moselle, about 370 A.D.), and Cassiodorus, (who first "brought into cloister life the fostering of science" and who wrote among other things of fish and their habits). Much later in time are Albertus Magnus, Conrad Gesner, Aldrovandi, John Ray, Leewenhoek,—and Isaac Walton, of course,—among scores of other familiar and non-familiar names. Then we find works of such local interest as John Smith, (fishes of Chesapeake Bay), Montanus (who, in "the latest and most accurate account of the New World," Amsterdam, 1671, gives data on fish and fishing), Lawson (fishes of North Carolina, 1709), Catesby (1731–), and Brickell. A wealth of interest lies between Abbeville and Zorgdrager, alphabetically, or between Homer and Linnaeus, chronologically.

But the scientist as such will be most concerned with the thousands of Post-Linnaean publications relating in one way or another to fish. To him the usefulness of the Bibliography requires no extended comment. We may, however, appropriately quote from the authors' preface to Volume III:

"Thus the chemist who studies the egg-yolk, the sanitary engineer who aims to destroy disease-bearing insects, the physiologist who seeks data on the regeneration of nerves, the student of the cancer problem, the anthropologist who describes the life-habits of primitive

peoples, the bacteriologist whose work touches diseases in fishes, the medical practitioner who would know the earlier hosts of certain parasites or about the oils digestible to his patients—even the amateur of heraldry, or the theologian—each and all of these will here find materials which concern his work."

Certainly, to all present and future students of fishes and of problems relating to fish, "A Bibliography of Fishes" will be more than a time-saver and "very present help in time of trouble"—it is an invaluable aid, an indispensable reference book. It cannot, of course, be accepted as complete. Omissions are bound to have occurred. Nevertheless, the authors have placed all investigators of subjects relating to fishes for all time under deep obligation. It is indeed reasonable to suppose that these volumes will be not infrequently used a thousand years from now: to be sure, the discovery of a book of this character published in 923 A.D. would be a boon to present-day students of the history of science!

Finally, the highest commendation may be given to the editorial and typographical work. The editorial plan of the book is successfully carried out and makes for the greatest efficiency and facility of use. The volumes are of convenient size, well put together with broad margins convenient for personal annotations. The differentiation of type is most effective. The pages are "easy to look at" and equally easy to use.

R. E. C.

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This book contains descriptions of all known species and direct observations on and illustrations of all American species of the family Saprolegniaceae. Notes are added on related families, as Leptomitaceae, Blastocladiaceae, and Monoblepharidaceae.

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